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# MANUAL OF CHARTING

# MANUAL OF CHARTING

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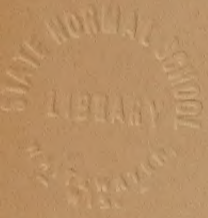

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# PREFACE

The first book on graphics in the English language was published in 1910. Since then many books have been brought out. Very few, if any, are sufficiently elementary to be of assistance to the beginner in the construction of graphic charts. With the increasing use of graphics in business, and in production and operation generally, the need has come for a simple, elementary book, stripped of technicalities and yet presenting the fundamental facts of graphics with accuracy and authority. This book purports to fill this need. It is designed to help the inexperienced to such an understanding of graphics as will enable them to continue the study intelligently.

It is quite as essential that the executive assistant should be able to select and read graphic charts with discrimination as it is that he should be able actually to prepare them. This he can do with greater facility if he has a good understanding of the basic principles underlying graphic construction.

The Editors.

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# Part One

# GRAPHICS IN GENERAL

# GRAPHICS IN GENERAL

## Chapter I

## FUNCTION OF GRAPHICS

**1. Introduction.**—The graphic method of presenting facts is coming to be more and more widely used. Engineers, accountants, administrators, teachers, executives, and others are using this method of making a concrete picture of conditions of different kinds. We are all familiar with tables which show the number of persons who have died in certain places, from certain causes, within a range of years; or which set forth the quantity and value of cotton exported from certain countries for certain years. Well-constructed tables of this sort are not only extremely valuable; they are indispensable. It has been found, however, that when these tables are translated into chart pictures, called graphs, they tell a more direct story more quickly to more people than do statistical data. Graphs, in a certain sense, are a universal language, comprehensible alike to the workman and to the executive, only, however, in so far as the story which they visualize goes. The interpretation of the visualized story, the working out of cause and effect which lie behind the picture—these are processes which require both experience and training. The production of well-made statistical tables presupposes that the compiler has mastered certain accepted rules and formulae. Faulty tables are of no value to anyone; indeed, they are a menace to many. The beginner in graphics is therefore to be cautioned in the use and selection of statistical material. It should not be difficult to distinguish between doubtful and acceptable sources. Material, the source of which is unknown, is undesirable because it is uncertain whether it is based on fact or on supposition. Material, on the other hand, the source of which is known, but which has obviously been compiled by inexperienced persons, is equally undesirable. The

importance of this will be realized when it is considered that the basis of charts, or graphs, is this very statistical material. Graphic charts are merely diagrammatic translations of statistical tabulations. A properly constructed chart never distorts the story of its statistical ancestor, any more than the statistical table distorts the story which it purports to tell, or any more than a good translation varies in fact from the original text.

**2. Comparison of statistics and graphics.**—In statistical tabulation it often happens that the true degree of difference in the various items is not readily apparent. This is most frequently due to the limitations of type display. To a large extent, it is also due to the fact already referred to, that undoubtedly masses of numerals make no direct impression other than to an unusually well-trained mind. Take a series of numbers having a wide degree of variability but expressed in the same number of digits, and consider whether the instantaneous visual effect produced by the figures 2444 and 9444, for instance, is commensurate with the actual difference. Even the use of heavy and light type to mark extreme variations from the average is of limited value.

When a series of numbers is plotted on a chart, the result is not only a register of the same numbers but also such a register of their variations as will at once compel a proper recognition not only of these variations, but of the degree of variation, as well. This result is rarely attained by means of columns of figures or pages of text. Examine the following tables. Note that the same set of facts is displayed in three different ways. Consider which one is the most likely to have the greatest appeal and also which one permits the quickest and most accurate analysis.

| *Exhibit* 1 | | *Exhibit* 2 | | *Exhibit* 3 | |
|---|---|---|---|---|---|
| May 1 | $6,589 | May 1 | **$6,589** | May 1 | $$$$$$$$$$$$$ |
| 8 | 2,310 | 8 | *2,310* | 8 | $$$$ |
| 15 | 4,279 | 15 | *4,279* | 15 | $$$$$$$ |
| 22 | 9,981 | 22 | **9,981** | 22 | $$$$$$$$$$$$$$$$$$$$ |
| Average | 5,789 | Average | 5,789 | Average | $$$$$$$$$$ |

Is it likely that the average person would, by a casual examination of either Exhibits 1 or 2 get the distinct impression produced by Exhibit 3? While the impression made by a graph is more direct than that conveyed by tabulation, it should be pointed out that tabulation is more accurate than graphic display.

**3. Graphics are illustrated statistics.**—Persons who find it difficult to grasp the full intent of a tabulation can, at a glance, read a fairly complex chart. Thousands of persons have enjoyed picturized books in moving pictures, who would never have read the books in the first place. Thousands of persons have become familiar with the rise and fall of the charted index number of the cost of living who would never have followed the index number itself. Thus many facts have been vitalized and their relationships indelibly impressed upon the public through the use of illustrated statistics. There are four ways of describing a fact or series of facts. It may be done by means of words, numerals, graphs, or by a combination of all three. Sometimes only the last will suffice to tell the whole story. More often the graph is sufficient.

## Problems

1. What advantages has the graphic method of statistical presentation over tabular presentation?
2. What are the disadvantages?
3. In what, chiefly, does the danger lie in the use of statistical material by the beginner?
4. Compare in your own words the relative properties of Exhibits 1, 2, and 3.

## Chapter II

## STATISTICAL SOURCES FOR GRAPHICS

**4. Federal, State, and local sources.**—Statistical sources may be either primary or secondary. Primary sources are those which exist in an unworked state, in the records of the business house, factory, or institution. Frequently, too, they may be collected for an industry by national associations. Secondary sources are those which have been worked over, compiled into certain relationships and tabulated. They may or may not necessarily have been printed.

Government departments, trade papers, and trade and technical associations are responsible for the greater amount of the secondary sources. The Federal Government issues such a vast quantity of statistical information that it would take the whole time of a good many persons to co-ordinate this information in such a way that the result would yield up all that had been printed at a given time on a given subject. There is at present no agency in existence which will enable the searcher after statistical information to find it readily. While this is true of a large percentage of government information, a certain amount of it is easily obtainable. The beginner in graph construction will do well to acquaint himself with these sources, for they are not only available and ready to use, but they are of unquestioned authority. The attention of the beginner should, however, be called specially to one feature of government statistical information, namely, its mutability. This applies particularly to the industrial statistics which emanate from the Department of Commerce and the Department of Agriculture. The continuity of statistical tabulations issued from these departments is constantly changed, and the bulletins in which they appear are frequently changed in form. Although a serious drawback, this is the only one which arises in the use of these statistics. The following list of sources comprises only those which are the most

available and the most permanent. References to the Statistical Abstract are made intentionally, because here, in the first instance, are given totals, for a series of years, of data collected from all statistics-issuing agencies of the Federal Government, and, in the second instance, the titles of the services are given, thus enabling the worker to search out the sources for more detailed information.

## Federal

*Agricultural Statistics.*

Statistical Abstract. Annual. U. S. Bureau of Foreign and Domestic Commerce. 50 cents a year. Summarizes all Federal agricultural statistics.

Weather, Crops and Markets. Weekly. (Continuing the former publications entitled Market Reporter and the Monthly Crop Reporter.) $1 a year. Currently collected statistics covering the field of agriculture.

Yearbook. Annual. U. S. Department of Agriculture. Summarizes departmental agricultural statistics.

*Areas.*

Irrigation Systems. Statistical Abstract.

Lands (forest, homestead, unappropriated, etc.), Statistical Abstract.

U. S. by States. Statistical Abstract.

*Army and Navy—U. S.*

Statistics (strength of, disbursements for). Statistical Abstract.

*Banks.*

Statistics (national, private, savings, State). Statistical Abstract.

*Building Operations.*

Mineral Resources of the U. S. Annual. U. S. Geological Survey. Gives number of permits and cost of buildings. Summary in Statistical Abstract.

*Business Conditions.*

Federal Reserve Banks. Each Federal Reserve bank issues a monthly bulletin, which contains a review of credit, banking, and business conditions in the district of the bank.

Survey of Current Business. Issued jointly by Bureaus of Census, Standards, and Foreign and Domestic Commerce. Monthly. $1 a year. Extensive tables of production and prices, index numbers, and textual discussion of business conditions.

*Coal.*

Statistics (produced, consumed, prices, etc.). Statistical Abstract.

*Commercial Statistics, U. S.—Domestic Trade.*

Rail-borne. Included in Interstate Commerce Commission monthly and annual statistics of railways.

Water-borne. Lakes, rivers, harbors and canals, also ports, by commodity, quantity, and value. Annual. U. S. Chief of Engineers.

*Commercial Statistics, U. S.—Foreign Trade: Sources.*

Monthly Summary of Foreign Commerce. Cumulates by fiscal year.

Commerce and Navigation. Annual. Issued by U. S. Bureau of Foreign and Domestic Commerce. $1 a year. Cumulates by calendar year.

*Commercial Statistics.—Foreign Trade: Summary.*

Statistical Abstract.

*Consumption.*

Foodstuffs. Statistical Abstract (annual).

Tobacco. Internal Revenue Bureau. Annual report.

Gold and Silver. Annual report, Director of the Mint.

*Cost of Living.*

Monthly Labor Review. Bureau of Labor Statistics.

*Cost of Production.*

Federal Trade Commission. Extensive cost of production studies, and reports on various industries.

Tariff Commission. The commodity studies of the Tariff Commission include much cost-of-production information.

*Debt.*

U. S. and World. Statistical Abstract.

*Financial Statistics.*

Receipts and disbursements. Statistical Abstract. Summary for series of years, by purposes.

*Fires.*

Statistics (number, value of losses) by cities of 100,000 and over population. Statistical Abstract.

*Fisheries.*

Statistics. Statistical Abstract.

*Hours of Labor: Sources.*

The bulletins of the U. S. Bureau of Labor Statistics are the source for relative union hours of work.

*Hours of Labor: Summary.*

Statistics of relative union hours of work as given in the bulletin of the U. S. Bureau of Labor Statistics are summarized in the Statistical Abstract.

*Income.*

Bureau of Internal Revenue. Statistics of income. An annual, appearing about eighteen months after the period covered, but a preliminary report is issued much earlier.

*Index Numbers.*

Two important bulletins have been issued by the U. S. Bureau of Labor Statistics on index numbers, viz., Bulletin No. 173 and Bulletin No. 284. The bulletins contain the history, scope, and operation of the recognized index numbers throughout the world.

*Insurance.*

Statistics for U. S. by kinds of insurance. Statistical Abstract.

*Legislation.*

The only official source for current Federal legislation is the Congressional Record Index. This is issued fortnightly during the session of Congress and includes a summarized history of every bill and resolution.

The Congressional Digest, monthly, published in Washington, D. C., unofficial, is a magazine devoted to summarized accounts of Congressional action.

The Chamber of Commerce of the United States of America also publishes a legislative review of the work of Congress, and maintains a service bureau to attend to inquiries directed to it.

*Lumber.*

Statistics of production by States, and kinds of wood. Statistical Abstract.

*Manufactures.*

Census Bureau. Decennial census reports cover: Population, Agriculture, Mining, Manufactures. Quinquennial, 1904 to 1919, a report on manufactures. A biennial census of manufactures is provided for. Annual publications include: Production and Distribution of cotton and of tobacco.

Monthly Survey of Current Business (in conjunction with the Bureau of Foreign and Domestic Commerce and the Bureau of Standards). Price $1 a year.

Statistical summaries of Census Bureau's tabulations. Statistical Abstract.

*Merchant Marine.*

Tonnage (lost, owned, and built). Statistical Abstract.

*Merchants.*

Population and Its Distribution. Pub. by J. W. Thompson Co., 1921. Retail and wholesale dealers enumerated and classified by trade. Arranged geographically. Taken from official and unofficial sources, but not available in any other form.

*Migration of Population—U. S.*

Statistical Abstract.

*Mineral Statistics.*

Mineral Resources of the U. S. Annual. U. S. Geological Survey. Issued annually in two parts—Metals and Non-metals. Appears about three years later than period covered, but the separate studies included in it are issued as reprints comparatively promptly. Production figures for the various industries covered are often available in an unrevised form very shortly after the end of the year.

*Municipal Statistics.*

Manufactures, population, receipts by source. Statistical Abstract.

*Population.*

Statistics—U. S. Statistical Abstract. These are abstracts of the census tabulations and the annual estimate, made in July, of accrued population.

*Power Statistics.*

The U. S. Geological Survey issues monthly statistics of power consumption and production.

*Prices.*

Coal—U. S. Statistical Abstract.
Foodstuffs—U. S. Statistical Abstract.
Textiles—U. S. Statistical Abstract.

*Production.*

Crops of all kinds. Statistical Abstract.
Minerals. Statistical Abstract.
Textile raw materials. Statistical Abstract.

*Railways.*

Mileage, U. S. and world. Statistical Abstract.

*Railroads.*

Statistics, U. S. Statistical Abstract.
Statistics of operation, revenue and expenditures. U. S. Interstate Commerce Commission. Currently (monthly) and in annual volumes.

*Wages: Sources.*

The bulletins of the U. S. Bureau of Labor Statistics are the source for relative union wages.

*Wage: Summary.*

Statistics for agricultural workers, in various manufacturing industries, for railroad workers, etc. Statistical Abstract.

*World Statistics.*

Basic statistics, such as debts, foreign trade, receipts and expenditures, shipping, etc. Statistical Abstract.

### State

The only means which the student has of keeping in touch with such statistical material as is published by the States is through the "Monthly Catalogue of State Publications," which is issued by the Library of Congress, and sold at 50 cents a

year. Many of the statistics indicated in the preceding list are summarized by States, and may thus be used in compiling data concerning one or more States. The Census Bureau also issues an annual volume on the "Financial Statistics of States," and the *Commercial and Financial Chronicle* issues a semi-annual "State" supplement which contains financial and other State statistics.

### Local

There is no central source for municipal or county statistics. The U. S. Census Bureau issues two annual volumes on municipal statistics, viz., one on financial statistics and one on general statistics. The *Commercial and Financial Chronicle* issues an annual "cities" supplement, which contains financial and other municipal statistics. The statistical supplement of the New York State Chamber of Commerce is, in effect, a statistical yearbook of the city of New York. The city of Cleveland has for the past two years issued a Cleveland Yearbook.

**5. Private sources.**—In addition to these public agencies there is a large number of private agencies issuing statistical material, or material which can be used as a basis. Among these are the publishers of commercial services, directories, and trade papers, trade associations, chambers of commerce, banks, and large trading houses.

### Commercial Services

The organization of private commercial services is of comparatively recent origin in this country. At the present time more than a hundred such services are in existence, some of which are doing business of very considerable proportions. The information which they issue comprises selected factors which are indicative either of existing business conditions, or the cause and effect of existing business conditions. This information is issued in both tabular and graphic form. The list here given represents only a few of the older and larger commercial services:

Business Digest Services, 70 Fifth Ave., New York City.
Standard Statistics Service, 47 West St., New York City.
Harvard Bureau of Business Research, Cambridge, Mass.
New York University Bureau of Business Research, 90 Trinity Place, New York City.

Northwestern University Bureau of Business Research, Evanston, Ill.

Brookmire Economic Service, 25 West 45th St., New York City.

Babson's Statistical Organization, Wellesley Hills, Mass.

### Directories

Other very useful sources of information in the compilation of statistics are trade and place directories. Directory publishers are organized into the Association of the North American Directory Publishers, the purpose of which is to maintain a standard service and to prevent the publication of unreliable directories. There are over 500 different trade directories, representing almost as many trades, issued in this country alone. Of class directories there may be mentioned those for physicians, lawyers, schools and denominations of different kinds, manufacturers, etc., while of trade directories it may be said that practically every major and many a minor industry has its trade directory. Some of these directories are so generally used that mention of them should be made here. These are first, the city directories published by the R. L. Polk Directory Co., Detroit, New York City, and St. Paul, Minn., which are largely used in making market analyses, and the following:

Hendricks' Commercial Register, 70 Fifth Ave., New York City.

Thomas' Register of American Manufacturers, 129 Lafayette St., New York City.

The beginner in graphics should be encouraged to take steps to familiarize himself with as many sources of information as possible. This can be done from time to time, but the habit should be formed of watching for sources from which material for graphic work may be culled. When such sources are located, a careful reference to them should be made immediately. Each of these references should then be transferred to a 3x5 inch card, on the upper margin of which is written the name of the kind of chart material carried in the

source. This will necessitate, in some cases, several cards for the same source. A sample is given here.

Organization Charts.—General Motors Corp.

Moody's Manual of R. Rs. and Corporation Securities. 22d. Ann. No. (1921) Vol. 1. (Chart shows four groups of mfg. units and four groups of sales units.)

These cards, when thrown into alphabetical order, will give the owner access to useful information without loss of time. If this habit of looking for and noting information is cultivated, it will soon develop into a critical sense in judging the characteristics and values of charts—a sense which in itself is an asset.

### Trade Associations and Chambers of Commerce

There are several thousand trade associations, chambers of commerce, and boards of trade in the United States, and nearly all of them are to a certain extent gatherers of statistics. The local chamber of commerce or board of trade is often the best source for current information concerning that particular locality. Occasionally, because of the industrial importance and geographical location, the local chamber of commerce is at least of regional, if not national, importance. Sometimes, also, the organization is in effect more like a trade association, and its yearbook then serves almost as does a handbook for an industry. The Chicago Board of Trade Yearbook has for over fifty years thus served the grain trade, and the New York Produce Exchange Annual Report is a mine of statistical information. There is no single volume which either lists completely or describes satisfactorily this class of organization, and until such a work is published, one will need to depend on the following publications as a method of approach to a single association or group of associations:

National Trade Associations, 248 pp., 1922. Published by the National Association of Manufacturers, 50 Church Street, New York City. A study of the organization and functions of over a hundred important associations.

Commercial Organizations of the United States, 121 pp., 1919. U. S. Bureau of Foreign and Domestic Commerce. Na-

tional and regional associations are also classified by subjects of interest.

Trade Associations, 386 pp., New York, 1921. Naylor, Emmet H. Organizations and activities. Lists more important large associations.

Employers' Associations in the United States, 594 pp., New York, 1922. Bonnet, Clarence E. Organization and policy of the more influential associations.

### Trade Periodicals, Annuals, Etc.

A number of trade and financial periodicals issue an annual review number sometime during the year, which usually contains statistical data in greater detail than may be found anywhere else. Some of the annual surveys are not duplicated by any other agencies, and have become established as the authorities for the field covered by them. Among the leading annuals of this character are:

New York Journal of Commerce (Incorporation, Finance, etc.).
Iron Age (Iron and Steel Prices).
Dun's Review (Failures, Price Index Numbers).
Bradstreet's Weekly (Failures, Price Index Numbers).
Oil, Paint and Drug Reporter (Oils, Paints, and Drugs).
Saward's Annual (Coal).
Coal Trade Journal Annual (Coal).
Price Current Grain Reporter Yearbook (Grain).
Northwestern Miller Miller's Almanac (Grain).
Railway Age (Railroad Finance).
Automotive Industries (Automobiles).

Where there is apparently no trade association or trade journal (the existence of the latter may be traced through Ayer's Newspaper Annual), it is often worth while to consult trade directories, such as Hendricks' Commercial Register or Thomas' Register of American Manufacturers. This latter directory attempts to give to each manufacturer a capital rating. In the absence of any better way, the aggregate of these capitalization ratings might be accepted as an index to the size or relative importance of a particular industry. It would also supply a means of determining how that industry was distributed over the country and, by the capital ratings, tell which firms would be most likely sources of information.

## Problems

1. What is the distinction between primary and secondary sources of information?
2. What are some of the drawbacks in using government statistics?
3. Describe a government publication which is a prolific source for all government statistics.
4. What are trade directories?
5. Name six leading trade papers which are of particular value in regard to the statistics which they provide.
6. If you desired to compare average prices of wheat, farm products, and all commodities, with the prices of a commodity manufactured by but one concern, from what sources would you attempt to obtain the necessary data?

## Chapter III

# EQUIPMENT

**6. Schedule and description.**—The equipment here described is not all essential at all times. Charts may, of course, be constructed from tables, using only a pencil and ordinary paper. Charts, however, intended for use or preservation require for their preparation some adequate equipment. That which is here described will acquaint the student with the essential materials required in preparing charts for preservation.

**Paper—drawing paper.**—Good drawing paper must combine several features. The student should be able to distinguish these so as to be able to make a selection suitable to his purpose. He should see first that it is uniform in thickness and surface, that it stretches evenly, that it neither repels nor absorbs liquids, that it stands considerable erasing without injuring the surface, and that it does not wrinkle when stretched or when liquids are applied to it. In color, drawing paper usually comes in various tints of white, cream, and pearl gray. A great many varieties of drawing paper are available. It is put up in sheets, rolls, blocks, and mounted on muslin, and may be purchased at retail in single units. A good drawing paper will not discolor with age or exposure.

**Paper—tracing paper and cloth.**—Both tracing cloth and tracing paper come in sheets as well as in rolls. They are used for reproducing charts by photoprinting, and also for drawing charts by hand.

**Paper—photoprinting—blue-print paper.**—There are three different processes in general use for reproducing charts by means of light, or photoprinting. These are: Blue print process, negative, white lines on blue background. Black print process, positive, black lines on white ground. Maduro process, negative, white lines on black ground.

When ordering these papers it is necessary to know the desired speed of exposure, and whether the prints are intended for sunlight or electric light exposure or for use in an electric printing machine. Blue print papers come in rolls of usually 10 or 50 yards to a roll. There are two kinds, viz.,prepared and insensitized papers. Each kind comes in several grades, viz., thin, thick, medium, and light weight. It may be ordered in quantity as wanted.

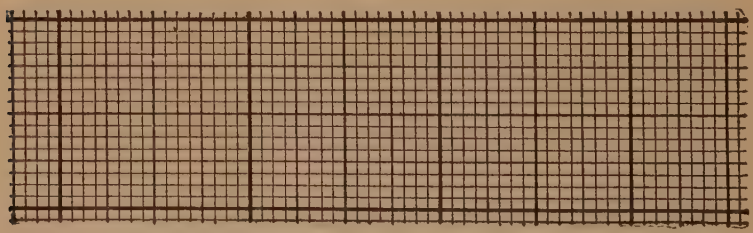
**Paper—photoprinting—black print process.**—This usually comes in rolls of 10 yards and is a prepared paper. It may be ordered in quantity as wanted.

**Paper—photoprinting—Maduro process.**—This kind of paper generally is available in rolls of 10 or 50 yards and is a prepared paper. It may be ordered in quantity as wanted.

**Paper—profile and cross section.**—This product is made up in sheets, rolls, blocks, and books, from drawing paper, tracing paper, or tracing cloth and is sometimes mounted on muslin. The rulings are of various kinds, both as to spacing and as to color. The unit for spacing is usually the inch or half inch. The spacing of cross section paper is in squares a certain number to the unit of measurement as: 16x16, 12x12, 10x10, 8x8, 6x6, 5x5, 4x4, etc.

The squares may be divided into groups of fives, fours, eights, etc., by heavy lines. The lines are usually printed in colors, either orange, green or blue.

Profile paper is not ruled in squares but in horizontal rulings of various numbers to the inch and in vertical rulings



*By Courtesy of Keuffel & Esser Co.*

**Fig. 1. Cross-Section Paper.**

of various numbers to the inch, the numbers not being equal. In other respects profile paper is the same as cross section paper.

**Paper—logarithmic.**—Logarithmic paper comes in sheets, ruled to show logarithmic scales in each direction and printed in colors like cross section paper. Logarithmic paper is used

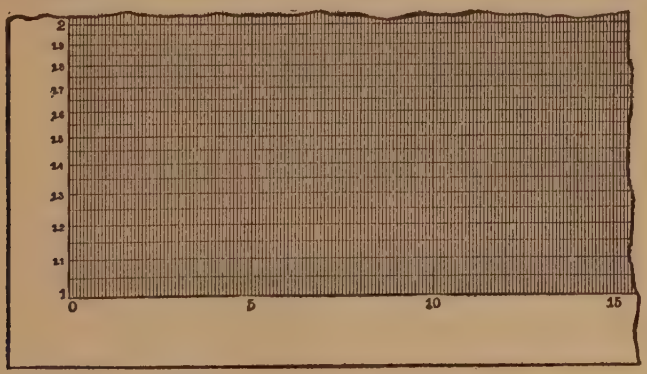
*By Courtesy of Keuffel & Esser Co.*

**Fig. 2. Profile Paper.**

to show relationships involving multiplication, division, raising to powers or the extraction of roots. Semi-logarithmic paper is used for plotting comparative statistics of similar kind but dissimilar magnitude. The vertical scale is logarithmic and the horizontal scale is uniformly spaced.

**Pounce.**—When tracing cloth will not take ink readily, pounce may be lightly dusted on the cloth and evenly rubbed in with a soft fabric, until the cloth has lost its gloss. The pounce should be thoroughly removed before applying the ink. It may also be used for restoring drawing paper after an ink eradicator has been used.

**Ink eradicators.**—These consist of fluids for the removal of ink. Directions for their use come with the preparations.




*By Courtesy of Keuffel & Esser Co.*

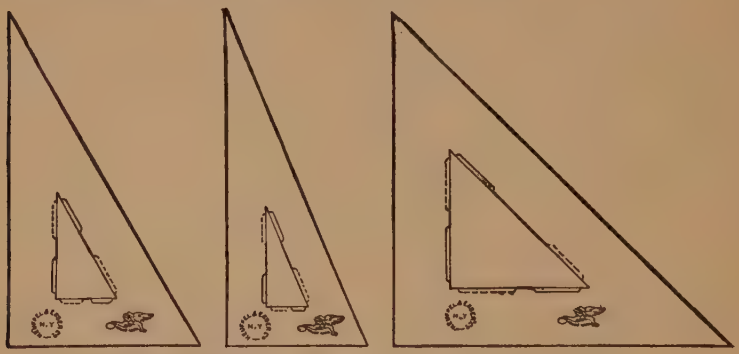
**Fig. 3. Semi-Logarithmic Paper, with Logarithmic Scale in One Direction, and Rectilinear in the Other Direction.**

**Drawing boards and tables.**—Drawing boards come usually in white pine, the simplest with end ledges of pine, or hard-

wood. The boards are of various sizes, ranging from about 12x17 inches to 60x120 inches, and the price from 70 cents to $58. Tables are of a great variety, with various attachments and accessories.

**T-squares.**—T-squares are made of wood of various kinds, often with steel blades. The wood-blade sizes vary from 15 to 72 inches and, according to the kind of wood used in the blade, range from 25 cents to $6 each in price. The steel-bladed T-squares are most expensive.

**Triangles.**—These come in wood, hard rubber, and metal. They range in size from a 4-inch to an 18-inch right angle, or the longest right angle edge when the two are unequal. The price range is from about 20 cents to $4 for the non-metal, the metal triangles ranging up to $7 or $8.



*By Courtesy of Keuffel & Esser Co.*

**Fig. 4. Three Types of Transparent Triangles.**

**Curves.**—Curves are instruments made of xylonite, hard rubber, pearwood, or cardboard in various shapes and sizes to assist the draftsman in curve-plotting. They are also used by the engineer and the machinist, and are necessary only in advanced work. Dealers in drawing materials keep them in stock.

*By Courtesy of Keuffel & Esser Co.*

**Fig. 5. Folding Parallel Rule.**

**Rules—parallel.**—Rules are instruments made of hard rubber, xylonite or ebony, with brass, German silver, or nickel-plated mountings, in various finishes. They are of roller or

folding construction. They are used for parallel rule work, and have no scale accessories.

**Rules—folding.**—These are the common inch rules made of tempered steel or hardwood in various lengths and folds.

**Scales—flat.**—Scales are instruments in rule form, flat or triangular, to which scales of various kinds have been affixed. They are made usually of well-seasoned boxwood. They are of two types, viz., open divided, and chain divided. The open divided scale is one in which the scale, while carried in units along the whole length of the edge, is subdivided only at the ends. The chain divided scale is one in which the subdivisions are carried out along the whole length of the edge. Open divided scales are used in architectural and mechanical drawing, and the chain divided scale is used by surveyors and engineers. The scales themselves are of different lengths, and the divisions on the scales are of various kinds. Examples of some of the divisions are:

Inch to the foot scale, divided into combinations of ⅛, ¼, ½, ⅜, ¾, 1½ inches to the foot.

Inches and tenths scale, divided into 10x50, 20x40, 30x60 and 80x100 parts to the inch.

Foot in hundredths scale, divided into 100x500, 200x400, 300x600, and 800x1000 parts to the foot.

Metric measure scale, divided into cm., mm. and half mm.

Inches and metric scale, divided into inches on one edge and in metric measure on the other, an arrangement which makes it very convenient when converting from one system into the other.

*By Courtesy of Keuffel & Esser Co.*

**Fig. 6. Open Divided Flat Scale with Four Different Divisions.**

**Scales—triangular.**—Whereas the flat scale may at most have four edges scaled, the triangular scale may have six edges scaled.

**Scales—square.**—The scales heretofore described are used by the architect, draughtsman, civil engineer, and mechanical engineer. A square scale with edges scaled is used by the printer, and is known by him as a pica rule. The scales on

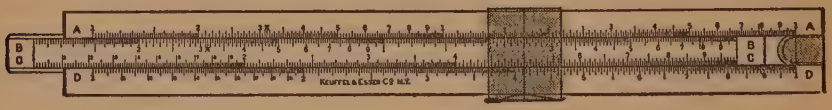
this rule are the points for the various sizes of type. It is used more particularly in estimating jobs than in graphics.

**Slide rule.**—The slide rule is a combination scale device which, in its present perfected state, has become an indispensable computing aid, not only to the engineer and scientist, but also to the manufacturer, merchant, and accountant.

There are several types of slide rules, and each type has several combinations of scales. An inexpensive slide rule for the student may be purchased for $1. This is intended for beginners, but the graduations are sufficient to enable the student to become familiar with the workings of the slide rule. There are several books on the subject, among them:

Cox, Wm.: The Slide Rule Complete Manual. Keuffel and Esser, price 50 cents.

Cullimore, A. R.: Use of the Slide Rule. Keuffel and Esser, price $1.



*By Courtesy of Keuffel & Esser Co.*

**Fig. 7. Student's Slide Rule.**

**Inks.**—Drawing inks should flow freely, dry quickly, and should have no tendency to gum. Imported India inks may be obtained, but a domestic India ink is commonly used. This comes in black and eleven other colors. It is put up in small bottles or in half pint, pint, and quart quantities. Indelible inks are those which will not redissolve after drying. This feature is variously described as indelible, waterproof, washable, etc. They come in black and colors put up in small bottles, quarter and half pints, and quarts.

**Pens.**—Probably the most necessary tool in the making of graphs is the pen. The sharpness of the point, flexibility, tendency to catch in the grain of the paper, or to scratch are characteristics to be noted in selecting drawing pens. Standard makes are on the market. Every graph-maker will have pens of varying point breadths on hand for different kinds of ruling and lettering. A free-hand lettering pen is the Payzant with a self-contained ink reservoir. For lettering on

very large graphs, this pen is of great use to the graph-maker. Double pens are often indispensable for certain kinds of work.

*By Courtesy of Keuffel & Esser Co.*

**Fig. 8. The Payzant Lettering Pen.**

## Problems

1. Obtain from two competing stores, catalogues listing the materials discussed in this chapter. Compare the prices, and the points of superiority claimed by each store.

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## Chapter IV

# CONVERSION OF STATISTICAL TABLES INTO GRAPHS

**7. Preliminaries of chart construction.**—The first step in the preparation of a chart is to understand the facts upon which the chart is to be based. Before beginning to construct a chart, the material to be charted should be studied carefully in order to make sure that all phases of it are clear in the mind of the person making the chart. This material should also be examined critically in order to make sure that it in its turn is not faulty or incomplete in execution. It is almost always desirable to include with the chart its statistical basis in a rather complete form. In that case the chart itself may be relieved of an excess of labeling. In no case should a chart be clogged or made obscure by superfluous lines or data. Its background should contain only so much as is necessary for easy interpretation. One of the greatest problems in chart construction is to secure the proper degree of compression. The truly successful chart is that one which displays the whole story within the limits of a single vision. No matter how well it has been constructed as to other features, if the eye has to rove to take in all the details, the result is far from ideal.

For this reason the use which is to be made of the chart should be the determining factor as to the degree of compression. The wall chart, for instance, which has to be consulted at a distance of several feet would be cumbersome at the directors' table. On the other hand, the general manager's vest pocket edition of the same chart would be no more effective than a spattering of ink if placed on the wall to advise the assembled officials.

**8. Rules of the joint committee on standards for graphic presentation.**—There are no accepted standards for the construction of charts. A few years ago, in 1915, a joint com-

mittee from the leading engineering societies drew up a tentative set of standards. While these have never been officially adopted by the societies, their publication has had the effect of influencing the construction of charts. In 1918, during the war, a carefully drawn-up set of rules was published in the since discontinued *Weekly Statistical News*. This was a wartime interdepartmental publication intended to serve as a clearing house for statistical data. As such it reached the desks of most of the many statisticians and economists then in Washington. Thus, while the *Weekly Statistical News* had a comparatively limited circulation, it did reach a great number of the leading people interested in statistics and graphic expression. Consequently the influence of the publication of these rules has been considerable, while at the same time the rules themselves are little known. Because of their conciseness, the rules of the Joint Committee are given here in full. A combination of both the Joint Committee's rules and those printed in the *Weekly Statistical News* is given in "Marshall on Graphical Methods," edition 1, p. 35.

1. The general arrangement of a diagram should proceed from left to right.

2. Where possible, represent quantities by linear magnitude, since areas or volumes are more likely to be misinterpreted.

3. For a curve the vertical scale, whenever practicable, should be so selected that the zero line will appear in the diagram.

4. If the zero line of the vertical scale will not normally appear in the curve diagram, the zero line should be shown by the use of a horizontal break in the diagram.

5. The zero lines for the scale for a curve should be sharply distinguished from the other co-ordinate lines.

6. For curves having a scale representing percentages, it is usually desirable to emphasize in some distinctive way the 100 per cent line or other line used as a basis of comparison.

7. When the scale of a diagram refers to dates, and the period represented is not a complete unit, it is better not to emphasize the first and last ordinates, since such a diagram does not represent the beginning and end of time.

8. When curves are drawn on $x$-log co-ordinates, the limiting lines should be at some power of ten of the log scale.

9. It is better not to show any more co-ordinate lines than necessary to guide the eye in reading the diagram.

10. The curve line should be sharply distinguished from the ruling.

11. In curves representing a series of observations, it is advisable, whenever possible, to indicate clearly on the diagram all the points representing the separate observations.

12. The horizontal scale for curves should be read from left to right, and the vertical scale from bottom to top.

13. Figures for the scale of a diagram should be placed at the left and the bottom or along the respective axes.

14. It is often desirable to include in the diagram the numerical data or formulae represented.

15. If numerical data is not included, it is desirable to give the data in tabular form accompanying the diagram.

16. All lettering should be placed so as to be read from one position.

17. The title should be clear and complete. Subtitles should be added to insure clearness.

**9. Description of various parts of statistical tables.**—In every industry, trade, and science there are terms peculiar to the processes and customs of each. A list of these terms, or of the terminology or nomenclature so employed, is called a glossary. Glossaries have been compiled and printed for many trades and industries. A recent example is the rubber glossary which appeared first in a series of installments in the *India Rubber World*, and has now been issued in book form. The U. S. Bureau of Mines has issued a "Glossary of Mining Terms." The nomenclature of statistics and graphics is very distinct. Comparatively it is not very large; just how large cannot be known exactly until an attempt has been made to compile and standardize it. When translating technical engineering formulae, for instance, into graphics, many technical terms necessarily have to be regarded, which in themselves have no relation to graphics. The same is true of translations from other subjects into graphics.

While the use of technical terms has been avoided in this book in describing the function, construction, and varieties of charts, students should be given the opportunity to become familiar with the more common terms. Not only will the use of the more advanced text-books employing such terms be

facilitated, but the student will also be better prepared to enter organizations where graphic work is being done by experienced persons.

Disregarding the information carried in these tables, let us examine the structure of the tables themselves. In the first place, observe that they are all composed of a series of vertical and horizontal rulings which carry certain words. Note that sometimes the rulings are single, sometimes double.

The double horizontal rulings are used to separate the result, or total, from the items composing it. The double vertical rulings are used to separate the several groups covered by the captions. These various rulings divide the structure of the table into the stub, the box, the column, and the plane, respectively.

**Table 1**

TONNAGE OF ALL VESSELS ENTERED AT ALL PORTS OF THE U. S.: 1910–1918

Unit: Net Tons

| | *Annual Tonnage* | *Cumulative Tonnage* |
|---|---|---|
| Total..... | 427,285,292 | |
| 1 | 2 | 3 |
| 1910 | 40,235,806 | 40,235,806 |
| 1911 | 42,674,989 | 82,910,795 |
| 1912 | 46,158,071 | 129,068,866 |
| 1913 | 50,639,173 | 179,708,139 |
| 1914 | 53,388,577 | 233,096,716 |
| 1915 | 46,710,466 | 279,807,182 |
| 1916 | 51,549,897 | 331,357,079 |
| 1917 | 50,472,176 | 381,829,255 |
| 1918 | 45,456,037 | 427,285,292 |

The stub is that part of the table which, in Table 1, carries the date. In general it may be said to be that part of the table which carries the series. The box is that part of the table which, in Table 1, carries the word "Tonnage," and in general may be said to carry the caption. The plane of the table is that part which, in Table 1, carries the amounts of the tonnage of vessels cleared. Note that the Total is set at the top instead of at the bottom of the column. This practice is coming more and more into use. The effect is to give the result, or total, in that part of the table which first

catches the eye after reading the title. Very often it is only the total which is required. The information which is carried in these parts of the table is respectively, the Title, the Caption, the Series, the Array, and the Unit of Measurement. The title in Table 1 is "Tonnage of Vessels Entered at all Ports of the U. S.: 1910-1918"; the captions are respectively "Annual Tonnage" and "Cumulative Tonnage." The term "Array" is applied variously, either to the information carried in the stub or in the plane. The series is always carried in the stub. A series may be of several kinds. In Tables 1-5 it is historical, that is, one of the scales of measurement is time.

In Table 1, the double vertical rulings indicate that the two columns divided by the rulings are to be regarded as distinct. The story of the facts told by the figures cannot be read cross-wise across the two columns. The story told by column 3 in Table 1 can be read only up and down. Examine the captions; note that the word "Tonnage" is repeated so that there may be no doubt as to the comparative factor. Observe the placement of the unit of measurement. This is always best placed immediately under the title. In writing or using titles, great care should be taken not only to observe that the exact information carried is expressed in the title, but that it is done as concisely as possible. If the words "Tonnage of" had, for instance, been omitted in the title of Table 1, the information conveyed would have been erroneous. The inexperienced user of tables and maker of graphs is often led astray by failure to observe distinctions in the title not especially indicated. In using immigration figures, for instance, very grave errors may result from failure to distinguish between the words "passenger" and "immigrant."

The caption of a table is a division of the title. The title describes concisely the whole table, the caption describes a portion of the table. This is better shown in Table 2 than in Table 1, and still better in Table 3.

A careful examination of the titles of tables should always be made before using them, and always before converting them into graphs. The exact unit of measurement should always be stated. The student cannot be too urgently cautioned to seek for the greatest precision in this regard in the material to be used. It may make a great deal of difference in calculation whether, for instance, net, long, short, displacement, gross, cargo or deadweight tonnage is the unit of measurement

or whether high, low, average, relative, or actual prices are the unit of measurement.

### Table 2

TONNAGE OF VESSELS ENTERED AT SEAPORTS AND AT ALL PORTS OF THE U. S.: 1910-1918

Unit: Net Tons

| | *Seaports* | *All Ports* |
|---|---|---|
| Total..... | 316,455,779 | 427,285,292 |
| 1 | 2 | 3 |
| 1910 | 30,916,794 | 40,236,806 |
| 1911 | 32,457,123 | 42,674,989 |
| 1912 | 34,659,086 | 46,158,071 |
| 1913 | 37,972,836 | 50,639,173 |
| 1914 | 40,052,289 | 53,388,577 |
| 1915 | 35,031,970 | 46,710,466 |
| 1916 | 37,744,179 | 51,549,817 |
| 1917 | 36,520,968 | 50,472,176 |
| 1918 | 31,100,534 | 45,456,037 |

Compare Tables 1 and 2. There is no difference in the tabular structure. Observe the expansion in the title to conform to the captions.

### Table 3

TONNAGE OF SAILING AND STEAM VESSELS ENTERED AT SEAPORTS AND ALL PORTS OF U. S.: 1910-1918

Unit: Net Tons

| | *Seaports* | | *Total* | *All Ports* |
|---|---|---|---|---|
| | *Sailing* | *Steam* | 316,455,779 | *Sailing & Steam* |
| 1 | 2 | 3 | 4 | 5 |
| 1910 | 1,526,103 | 29,390,691 | 30,916,794 | 40,235,806 |
| 1911 | 1,453,898 | 31,033,225 | 32,457,123 | 42,674,989 |
| 1912 | 1,524,011 | 33,135,075 | 34,659,086 | 46,158,071 |
| 1913 | 1,733,615 | 36,239,221 | 37,972,836 | 50,639,173 |
| 1914 | 1,550,587 | 38,501,702 | 40,052,289 | 53,388,577 |
| 1915 | 1,604,742 | 33,427,228 | 35,031,970 | 46,710,466 |
| 1916 | 2,137,178 | 35,607,001 | 37,744,179 | 51,549,897 |
| 1917 | 2,123,239 | 34,397,729 | 36,520,968 | 50,472,176 |
| 1918 | 1,788,713 | 29,311,821 | 31,100,534 | 45,456,037 |

In Table 3 we have an expansion of Tables 1 and 2. Note also the corresponding expansion in the title and observe the

vertical double ruling used as a separator for two groups, the records of one of which can be read cross-wise.

**Table 4**

TONNAGE OF AMERICAN AND FOREIGN SAILING AND STEAM VESSELS AT SEAPORTS AND ALL PORTS OF THE U. S.: 1910-1918

Unit: Net Tons

| | | *Seaports* | | | | *All Ports* | |
|---|---|---|---|---|---|---|---|
| | | *Sailing* | | *Steam* | | *Sailing and Steam* | |
| | | *American* | *Foreign* | *American* | *Foreign* | *American* | *Foreign* |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1910 | 433,704 | 1,092,399 | 3,780,524 | 25,610,167 | 8,888,459 | 31,347,347 |
| 2 | 1911 | 415,932 | 1,037,966 | 3,885,851 | 27,117,374 | 9,692,770 | 32,982,219 |
| 3 | 1912 | 565,348 | 958,663 | 4,006,316 | 29,128,759 | 11,257,098 | 34,900,973 |
| 4 | 1913 | 714,646 | 1,018,969 | 4,526,655 | 31,712,566 | 13,072,567 | 37,566,606 |
| 5 | 1914 | 562,441 | 988,146 | 4,873,353 | 33,628,349 | 13,730,075 | 39,658,502 |
| 6 | 1915 | 661,493 | 943,249 | 6,168,412 | 27,258,816 | 13,275,454 | 33,435,012 |
| 7 | 1916 | 998,524 | 1,138,654 | 8,447,363 | 27,159,638 | 17,927,674 | 33,622,223 |
| 8 | 1917 | 1,143,859 | 979,380 | 9,753,826 | 24,643,903 | 18,724,710 | 31,747,466 |
| 9 | 1918 | 951,699 | 837,014 | 10,304,385 | 19,007,436 | 19,283,530 | 26,172,507 |

Note here the further expansion of the title. Here also we have for the first time two vertical double rulings to indicate several groups of columns, the records of each of which may be read cross-wise. Note that only one of these double vertical rulings extends to the uppermost ruling. Compare the captions of Tables 1, 2 and 3. The student can experiment here, by changing the words in the minor captions to "American" and "Foreign," and those in columns 2 and 4 to "Sailing" and in columns 3 and 5 to "Steam." Change columns 6 and 7 correspondingly. Add rulings for totals and note the difference in the character of the story told by the table. Note that all tables are open on the sides. This is the more modern practice. Observe also that all columns are numbered, and, in Table 4, both lines and columns are numbered. This numbering of columns and lines is a foreign custom, but one which is being gradually adopted in this country. It has this advantage: when it becomes necessary in the accompanying text to refer to a certain figure, it can be done more concisely by saying, "Table 4, line 5, column 4" than, for instance, the equivalent, in this case, "the tonnage of American steam vessels entered at seaports of the U. S. in 1914."

**Table 5**

| | |
|---|---|
| 1910 | 40,235,806 |
| 1911 | 42,674,989 |
| 1912 | 46,158,071 |
| 1913 | 50,639,173 |
| 1914 | 53,388,577 |
| 1915 | 46,710,466 |
| 1916 | 51,549,897 |
| 1917 | 50,472,176 |
| 1918 | 45,456,037 |

In Table 5, note the division of the table into equal groups. This practice is not uncommon when a definite period of time is tabulated. The object is to facilitate group comparison, and the blanks, like rulings, help guide the eye in large tables Usually the division is made into five-year groups.

Economists, sociologists and biologists are constantly making studies of group numbers on the basis of normality. They do this on the theory that they can arrive at a correct understanding of conditions only when it is known how the various groups compare with a standard group. Two processes are involved, first measurement and then counting the repetition of the measurements. Take weights of school children, for instance. Each child is weighed, and as many other factors are noted as may have an effect on the weight, viz., age, sex, nationality, occupation of parents, etc. All the weights are first counted and arranged in groups showing how many children fall within each group, or each weight. This gives a certain general picture, but not an exact picture until the other factors are taken into consideration and also counted. Tables which are the result of observations of this sort are called frequency tables.

Here we have a new type of table. The scale of measurement is not time but group numbers. Tables 6 to 9 are examples of frequency tables. Note that the primary common characteristic of the frequency table is the statement of

## Table 6

DISTRIBUTION OF THE POPULATION OF THE STATE OF VIRGINIA: CENSUS OF 1920

| *Class of Place* | *No. of Places* | *Population* | *Per Cent* |
|---|---|---|---|
| Total..... | ..... | 2,309,187 | 100 |
| Urban territory..... | 39 | 673,984 | 29.2 |
| 100,000 and over..... | 2 | 287,444 | 12.5 |
| 50,000 to 100,000... | 2 | 105,229 | 4.6 |
| 25,000 to 50,000... | 3 | 96,678 | 4.2 |
| 15,000 to 25,000... | 2 | 39,599 | 1.7 |
| 10,000 to 15,000... | 3 | 28,040 | 1.2 |
| 5,000 to 10,000... | 9 | 58,694 | 2.5 |
| 2,000 to 5,000... | 18 | 58,300 | 2.5 |
| Rural territory..... | ..... | 1,635,203 | 70.8 |
| 1,000 to 2,500..... | 47 | 70,438 | 3.0 |
| 500 to 1,000..... | 38 | 25,701 | 1.1 |
| Under 500..... | 79 | 24,644 | 1.1 |
| Other rural territory.. | ..... | 1,514,420 | 65.6 |

repetitions in certain groups or classes; so many places of a certain size (Table 6), so many wages of a certain quantity (Table 7), so many companies reporting income or loss (Table 8), so many employees working a certain number of hours (Table 9).

Two attributes of these classes or groups or series are significant and affect the conversion of the tables into graphs. These two attributes are respectively the continuity or non-continuity of the series. In Table 7 continuity may be said to exist, that is, there is no break in the series, and it is therefore referred to as a "continuous series." In Table 8, on the contrary, the continuity is interrupted; there is a break. A series of this sort is referred to as a "discrete series."

There is another attribute of the series in these frequency tables which affects their conversion into graphs. This is the distribution of the groupings. Examine Table 6 and note the groupings under the caption "Urban Territory." They range from a minimum of 2,500 to a definite maximum of 100,000, the "and over" being considered an open class,

Beginning with the minimum of 2,500, the upward gradation is in steps respectively of 2,500, 5,000, 10,000, 25,000, and 50,000, these figures being the spread respectively in each one of the classes. The spread of the first class, viz., 2,500 to 5,000 is referred to as the boundary of that class, or, "class boundary," the class boundary of the second class being 5,000, and so on. By spacing this table to show the grouping of these classes, there are derived what are known as "class intervals," or the distance between any two class boundaries.

Note the variation in these class boundaries in Table 7. Beginning at the top, in the first group it is 5; in the second group it is 10, in the third group it is 25, in the fourth group it is 50 and in the last group it is 100. It is, obviously, not possible to compare these several groups with each other, nor does the table as a whole, present an accurate picture.

## Table 7

BITUMINOUS COAL MINING CONCERNS DISTRIBUTED ACCORDING TO NET INCOME OR NET LOSS TO INVESTED CAPITAL: 1918

| | *Income to Invested Capital* | *No.* | *Loss to Invested Capital* | *No.* |
|---|---|---|---|---|
| Total No. 1551 | *Per Cent* | 1214 | *Per Cent* | 337 |
| | Less than 5% | 168 | Less than 5% | 106 |
| | 5 to 9.99 | 159 | 5 to 9.99 | 58 |
| | 10 to 14.99 | 158 | 10 to 14.99 | 32 |
| | 15 to 19.99 | 134 | 15 to 19.99 | 29 |
| | 20 to 24.99 | 103 | 20 to 24.99 | 20 |
| | 25 to 29.99 | 66 | 25 and over | 92 |
| | 30 to 39.99 | 125 | | |
| | 40 to 49.99 | 74 | | |
| | 50 to 74.99 | 97 | | |
| | 75 to 99.99 | 65 | | |
| | 100 to 149.99 | 39 | | |
| | 150 to 199.99 | 12 | | |
| | 200 to 299.99 | 8 | | |
| | 300 to 399.99 | 2 | | |
| | 400 to 499.99 | 2 | | |
| | 500 and over | 2 | | |

## Table 8

HOURS OF LABOR IN DENMARK

| Hours per Day | 1918 | 1919 |
|---|---|---|
| | No. of Employees | No. of Employees |
| Total | 175,342 | 175,342 |
| Under 8 | 791 | 791 |
| 8 | 8,891 | 17,343 |
| 8½ | 8,891 | 98,013 |
| 9 | 29,661 | 59,195 |
| 9½ | 68,352 | |
| 10 | 53,072 | |
| Over 10 | 6,123 | |

## Table 9

HOURS OF LABOR IN DENMARK

| Hours per Day | 1918 | "——Or Less Than" | "——Or More Than" |
|---|---|---|---|
| | No. of Employees | | |
| Total | 175,342 | 175,342 | 175,342 |
| *1* | *2* | *3* | *4* |
| Under 8 | 791 | 791 | 175,342 |
| 8 | 8,452 | 9,213 | 174,551 |
| 8½ | 8,891 | 18,104 | 166,099 |
| 9 | 29,661 | 47,765 | 157,208 |
| 9½ | 68,352 | 116,117 | 127,547 |
| 10 | 53,072 | 169,189 | 59,195 |
| Over 10 | 6,123 | 175,342 | 6,123 |

The picture which is obtained by a frequency table shows in which group the greatest number of repetitions occur, such as, for instance, which group of income is most frequent, at which hour or season the greatest number of accidents occur, and so on. The distribution of the remaining frequencies from the point of greatest repetition to the disappearing point is called "dispersion." When this "dispersion" is studied in the mass, it has been observed that it tends to be directed away from the cluster point of greatest frequency in an unsymmetrical fashion. When this exists, "skewness" exists; when there is symmetry in the distribution, skewness is non-existant.

For instance, refer to Table 9, column 2. Note that the greatest number of employees work 9½ hours a day. This, then, is the cluster point for this tabulation, and means that 9½ hours a day is the length of the working for the majority of employees in Denmark. Note in column 1 that the increase and decrease in the number of hours is shown in steps of half an hour. Note the great drop in numbers of those who work 9 hours, viz. 38,691 less. Compare this with the drop in the number who work half an hour more than the majority, or 10 hours, viz. 15,280 workers less. Note that the total number of employees who work less than 9½ hours is distributed, or dispersed, over many more steps than is the number who work more than 9½ hours. The dispersion, then, may be said to be unsymmetrical and, consequently, "skewness" exists. Columns 3 and 4 of Table 9 carry cumulative tabulations. Column 3 shows that of 175,342 employees, 791 work less than 8 hours daily, 9,213 work 8 hours or less, and 18,104 work 8½ hours or less, and so on. Column 4 shows that of the total number of employees, 174,551 work more than 8 hours, 166,099 work more than 8½ hours, and so on. Column 3 is called an ascending frequency table or a "less than" table, and column 4 is called a descending frequency table or a "more than" table.

We have now learned the common terms and their application in statistical tabulation. We shall now proceed to convert these statistical tables into graphs, and to learn new terms for the parts of a graph.

**10. Description of various parts of graphs.**—While these tables are the material from which graphs are converted, the graphs, when so converted have been given an entirely new set of names. These names, it is true, apply largely to those graphs drawn on co-ordinate scales, graphs that may be called general-purpose graphs. This name will distinguish them from the scientific graphs, illustrating processes in engineering, chemistry, and so forth.

The co-ordinate graph is drawn on cross-section paper, from a base point at the intersection of a vertical and horizontal line. It is composed, like the statistical table, of (a) carrier of information, and (b) information. The ruling here is rectilinear, scored in fives. The base point or point of origin, where the calculation for the graph begins, is indicated

by the zero and represents the point from which measurement begins. Zero is located at the intersection of the two axes.

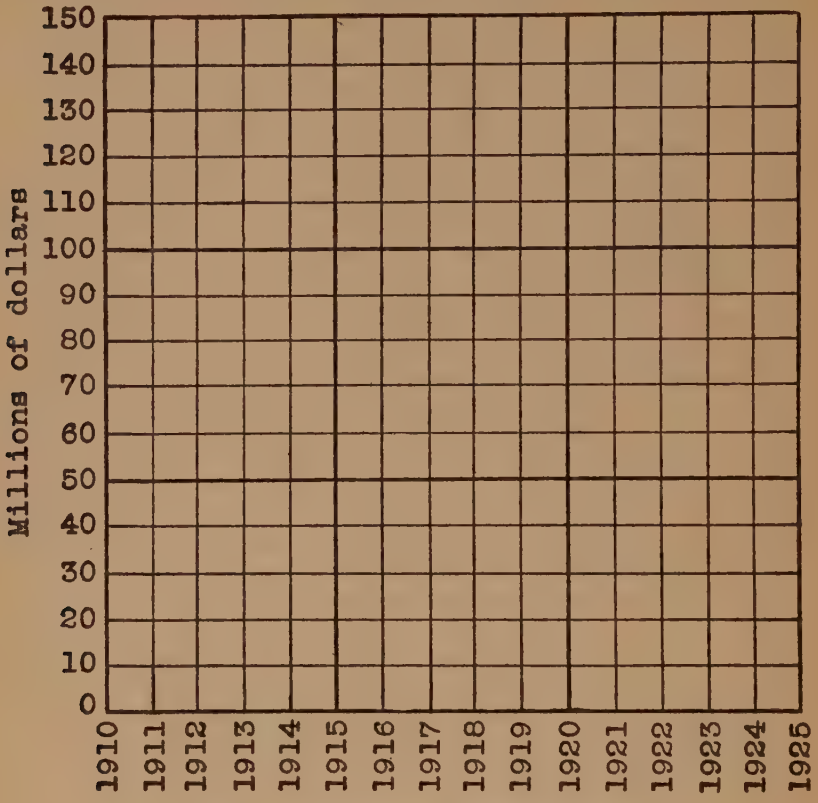



Fig. 9. Background for Co-ordinate Graph.

Any two of these intersecting axes are termed co-ordinate axes. The vertical axis is the ordinate, or $y$-axis. The horizontal axis is the abscissa, or $x$-axis. The scale on the ordinate axis is the ordinate or $y$-scale, while that on the abscissa axis is the abscissa, or $x$-scale. The vertical scale is a matter of choice. It is usually shown in decimals, but the spread of the decimals must be determined by the table which is to be converted. A very large measure of the success of graphic conversion depends upon the judgment with which the vertical scale is chosen. It is the carrier of the dependent variable which is the item being measured against the standard, or independent, variable on the horizontal scale. There are many different kinds of ruled papers for different purposes. Those

most commonly used are described in the chapter on equipment.

The student has now learned the structure and terminology of simple statistical tables and the structure and terminology of the carrier for general-purpose graphs. He is now ready to convert the simple table into a simple graph and apply it to the carrier.

**11. Conversion of tables into graphs.**—Referring again to Tables 1 to 4, it will be seen that they are simple historical tables showing a succession of items. There is no comparison, no grouping, no measurement of any sort. They show simply movement, or progression, the rise and fall being, in this case, a quantity gradation. Frequently it is a value gradation. Tables of this sort, converted into graphs, make simple curve-charts, the familiar rising and falling line showing high and low peaks of movement. This is the curve. Tables and curves of this sort answer simply the question how much of anything happened (exported, imported, cleared, etc.) in each fraction of time (day, month, or year) for a given length of time.

Suppose, however, it were necessary to show the total amount of tonnage cleared in the period from 1910 to 1918.

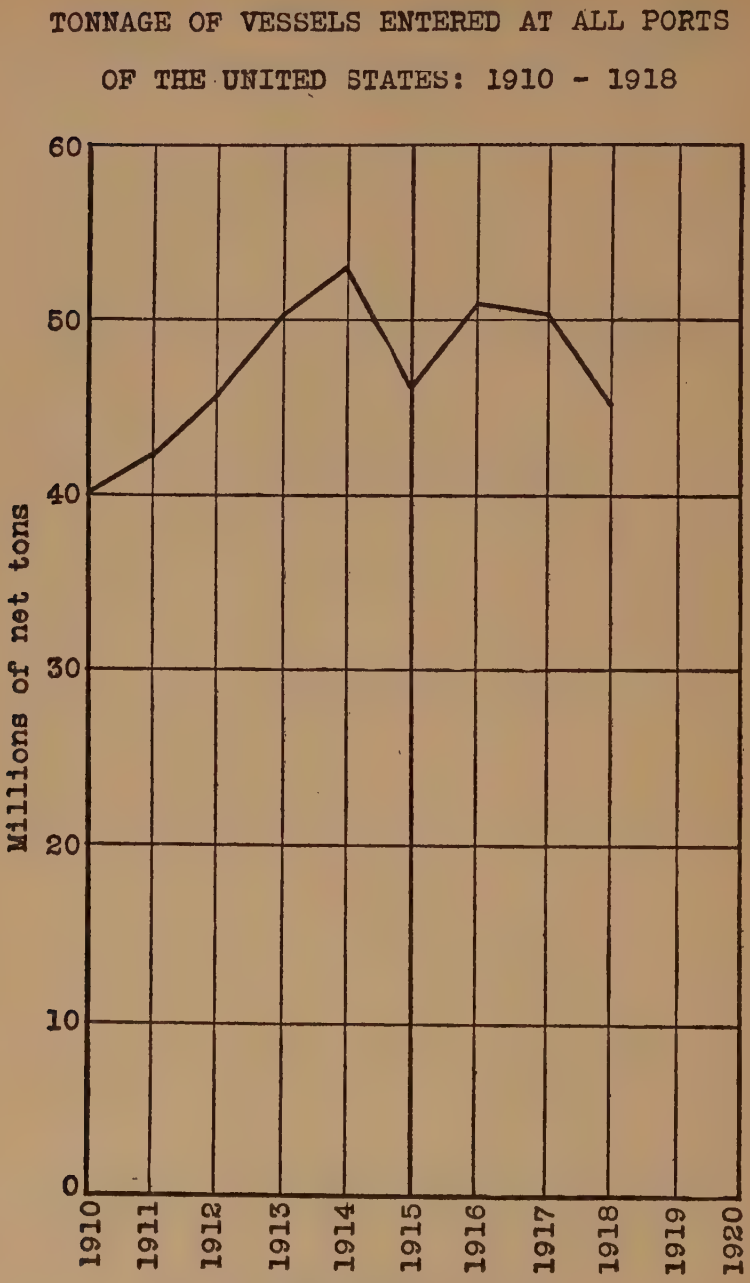



Fig. 10. Graph Converted from Table 1.

This is done by cumulative addition in the table and is converted into a graph as follows:

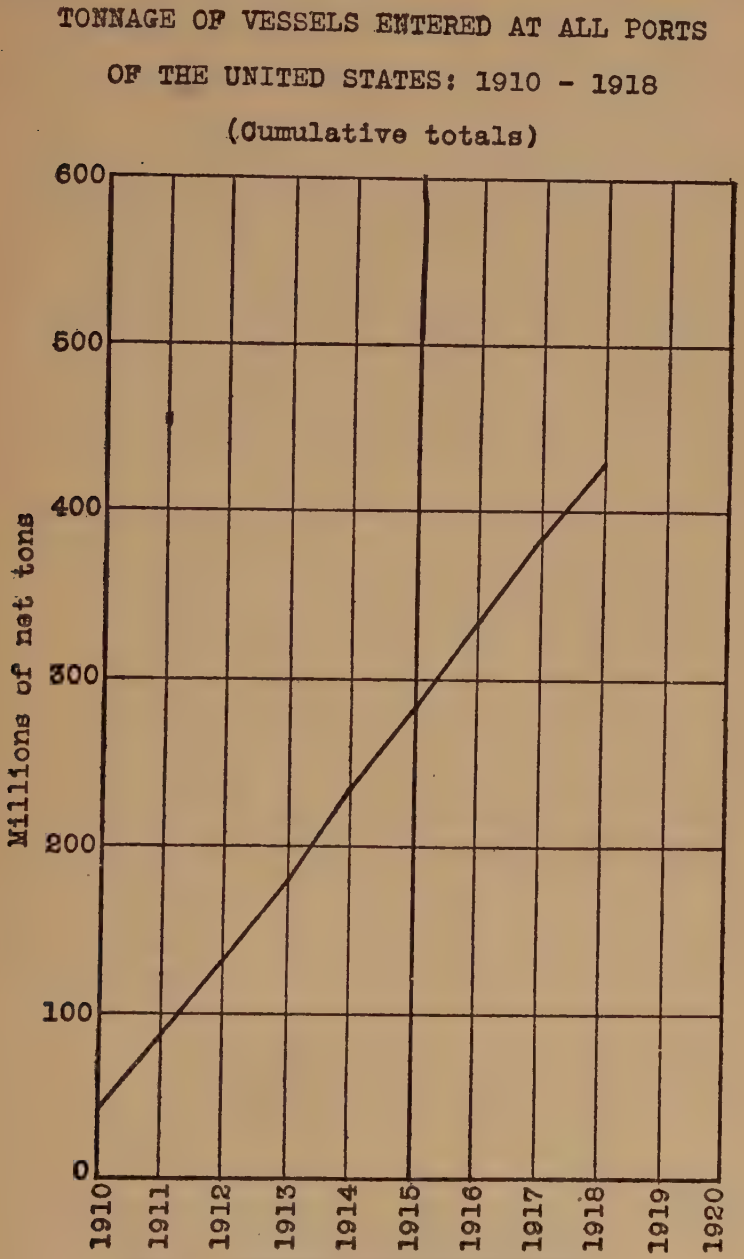



Fig. 11. Histogram Converted from Table 1.

We have now been shown the annual tonnage and the total or cumulative tonnage in curve-charts.

There are several other considerations which might be plotted. For instance, it might be desirable to know what percentage of the whole amount of tonnage cleared was cleared in a given year. Percentages are best shown on disc-charts, the preparation of which is described in chapter 5. It will be well at this point if the student examines the placing of the scales on graphs so far shown. The selection of scales is a matter of judgment. If the student will plot the same data used in these graphs on other scales, he will gain a very useful impression of the working of the scales, both ordinate and abscissa.

Tables 6 to 9 are not historical tables but frequency tables; that is, they show the number of times a given item has occurred.

A frequency table may be simple, such as that shown in Table 8, or it may be a cumulative frequency table, derived just as the simple cumulative table previously discussed (p. 32 was derived and shown in columns 3 and 4 of Table 9. The graph of Table 8 on page 39, shows the well-known curve for a simple frequency table.

Very briefly the theory of a frequency table is this. Phenomena measured according to frequency of occurrence have been found to have a mass norm. This represents the greatest number of occurrences of equal average similarity. From this mass norm the difference in equality spreads away toward both extremes. No matter what is measured, whether biological cases or social or economic facts, this general deviation will be found. What becomes a subject of statistical study is the character of the deviation in the two spreads and the extent of the mass surrounding the norm. To record these variations is the purpose of the frequency table and to visualize them is the purpose of the graph converted from the frequency table. This graph, which is called a histogram, always has the same general bell-like outline as shown by the outside of the graph. The term applied to this arbitrary symmetrizing of a graph is "smoothing." The law, the deviations from which are disclosed by the frequency table, is called "the normal law of error."

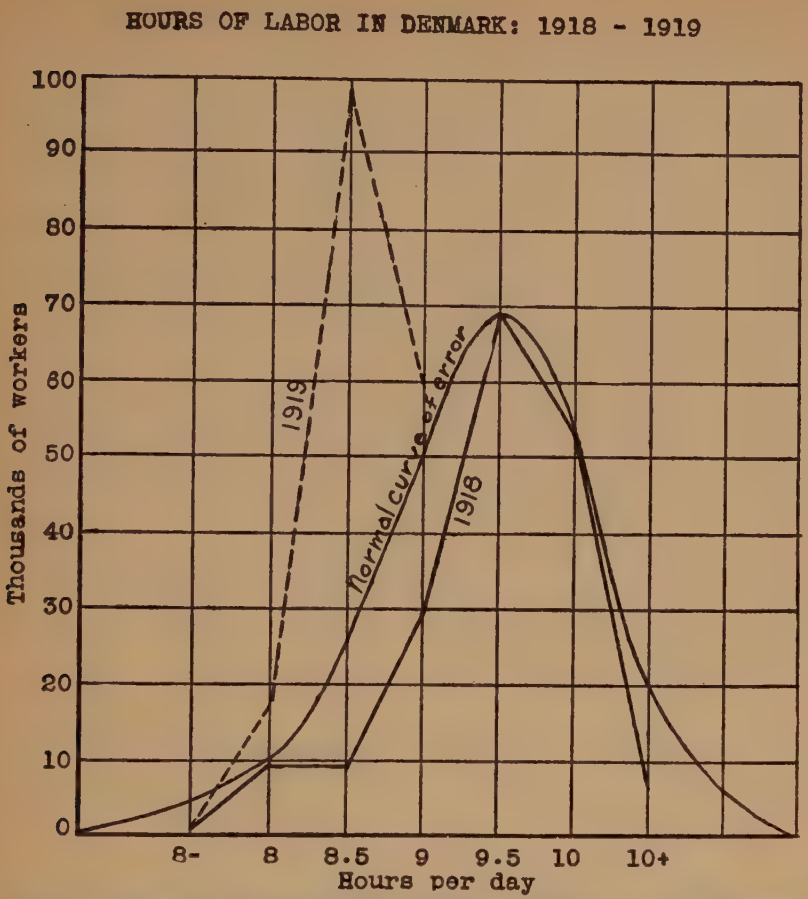



**Fig. 12. Histogram Converted from Table 8. Observe that the Histogram May be Shown with Equal Propriety by Either a Curve- or Bar-chart.**

Examine Table 9, and observe that the first two columns are identical with the first two columns of Table 8. Columns 3 and 4 of Table 9 are, it will readily be seen, derived respectively by cumulative addition and by subtraction. They represent the conversion of a simple frequency table into a cumulative frequency table. What is the purpose of this process and what does it disclose?

In column 3 the process is cumulative by addition. This process, shown here numerically, discloses simply the number of workers of the total number of workers who worked less than the number of hours shown by the next stub on the line below. It shows that of 175,342 workers in 1918, 116,117

worked 9½ hours or less, or that 18,104 worked 8½ hours or less, and so on.

In column 4 the process is subtraction. This process, shown here numerically, discloses simply the reverse of that shown in column 3, namely that number of workers of the total number who worked more than the number of hours shown in the stub. It reveals, for instance, that of 175,342 workers, over 127,547 worked more than 9½ hours. These tables are called cumulative frequency tables, and when converted into graphs, the curves are called ogives.

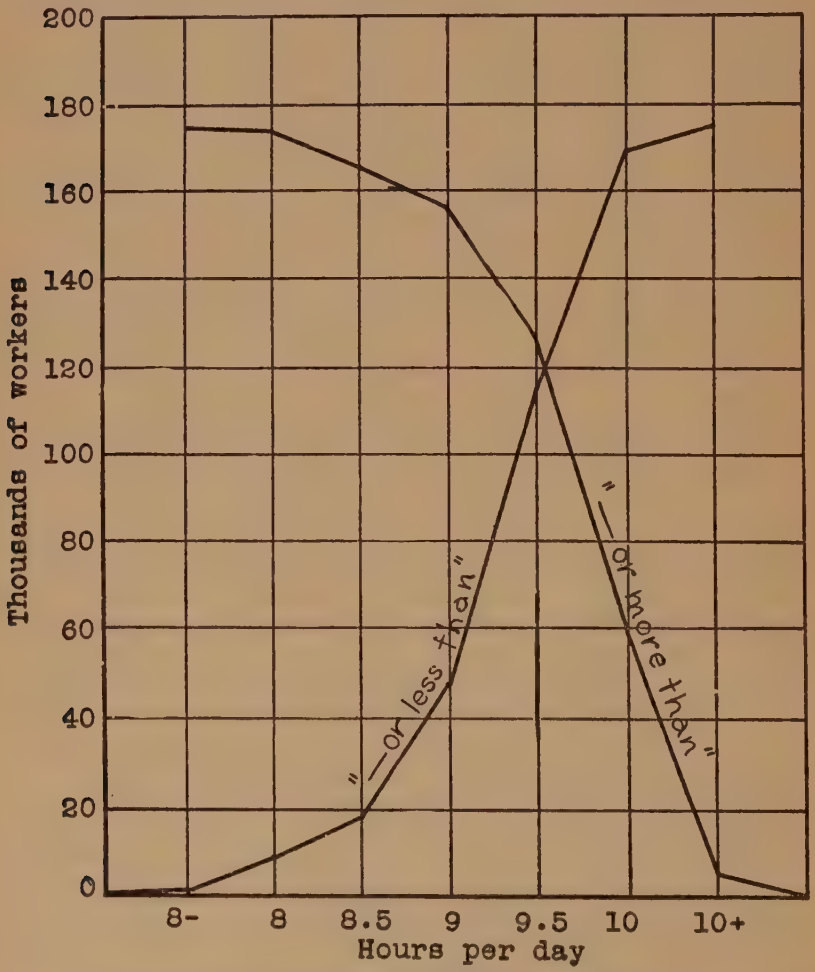



Fig. 13. Ogive Converted from Table 9, Columns 3 and 4.

## Problems

1. What efforts have been made to standardize chart construction?

2. Name and describe the purpose of five parts of the structure of a statistical table.

3. Name and describe three branches of the information which may be carried in a historical table.

4. Analyze the stub in Table 7.

5. Cite the variable in Table 9.

6. Describe a device to lessen the chance of error in reference, which may be applied to statistical tables.

7. What is a unit of measurement?

8. What is meant by series?

9. Name and describe the purpose of five parts of the structure upon which a graph is calculated.

10. Name and describe four kinds of statistical tables and the corresponding graphs.

11. Arrange the following in a table which will be in accord with the foregoing chapter:

Comparative losses in leakage, evaporation and residue from manufacturing linseed oil by the new and old processes.

| | | |
|---|---|---|
| New process: | evaporation | 3 per cent. |
| | leakage | 5 per cent. |
| | residue | 4.9 per cent. |
| Old process: | evaporation | 2 per cent. |
| | leakage | 2 per cent. |
| | residue | 4.1 per cent. |

12. Arrange the following in a table in accordance with the foregoing chapter:

Number of accidents per 1000 employees according to age groups for the years 1910 and 1920:

For 1910, 21 to 25 years, 49 accidents.
26 to 30 years, 42 accidents.
31 to 35 years, 27 accidents.
41 to 45 years, 38 accidents.
46 to 50 years, 39 accidents.
36 to 40 years, 28 accidents.

For 1920, the accidents for the age-groups as given for 1910 when properly arranged were 41, 33, 28, 29, 40, 35.

# Part Two

# KINDS OF GRAPHIC CHARTS

## Chapter V

# CLASSIFICATION OF CHARTS

**12. Introduction: plan and comparison charts.**—Roughly speaking, charts may be grouped into three general classes. In the first place, there are the charts used by specialists in scientific calculations, comprising chiefly properties of matter, the operations of scientific instruments or machinery, and so forth. In the second place, there are charts which have a general engineering application, comprising chiefly the properties of raw materials, performance records of machinery, and similar matters. In group three belong those charts with which we are chiefly concerned in this book. In general, these comprise records of economic and social conditions, and are sometimes referred to as general-purpose charts. These latter are again divisible into plan charts and comparison charts. Each of these groups has a limited number of forms, but each form of chart may have several variations, which may be called types.

Plan charts are divided into three general forms: 1. Organization; 2, Procedure; and 3, Floor. Organization and procedure charts are usually made up of circles, squares, rectangles, triangles, and so forth, connected by lines to indicate the relationship of one to another. Each block is labeled by its name or marked by legend to tell what part in the whole plan it is to perform. There has been little standardization of practice in the construction of these charts, but more than a casual examination of many apparently different types reveals that they all rest on three or four simple principles. Floor charts merely represent the physical layout of an office or factory with its furniture or machinery equipment drawn to a scale and placed in position, to permit an accurate visualization of the relationships or processes that are carried on under the conditions displayed. That relationship is usually shown by some form of line or lines connecting the points or steps of a process that have been plotted on the chart.

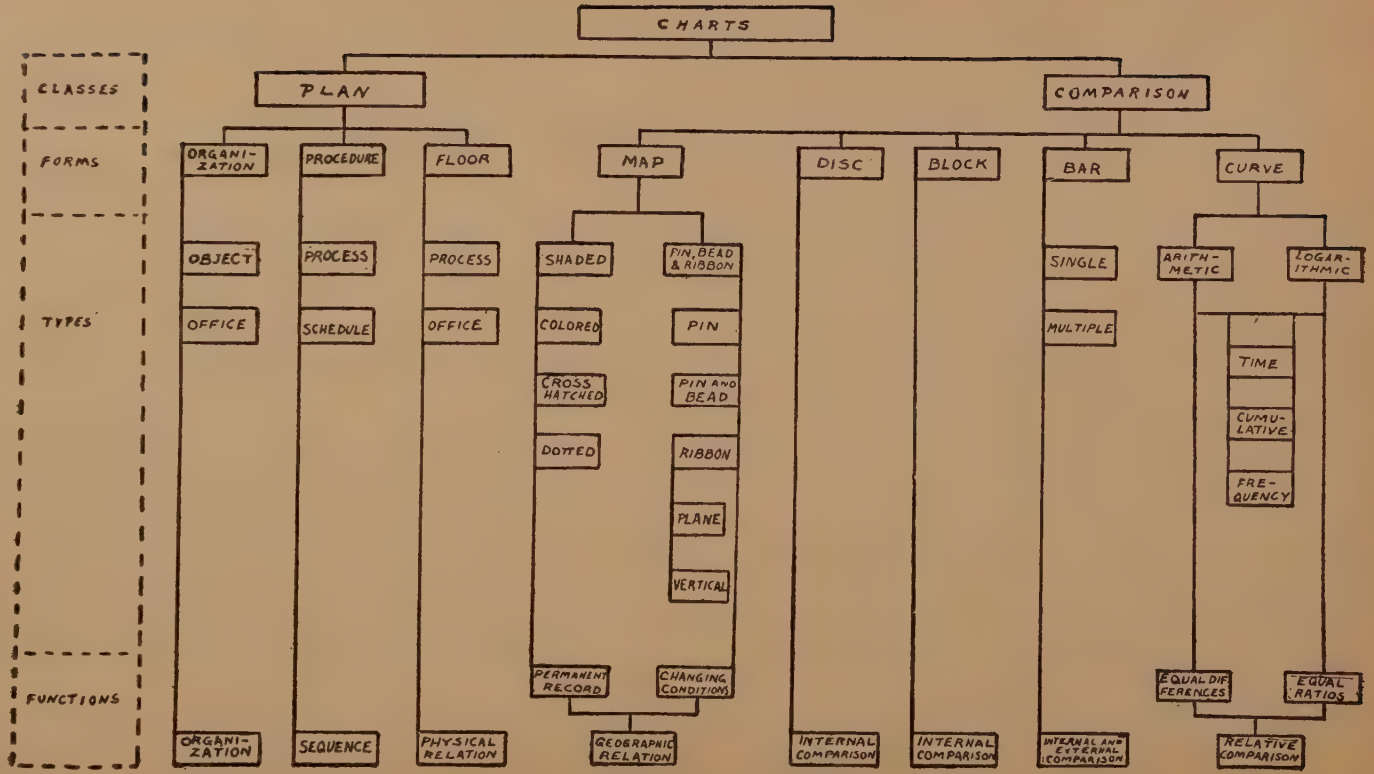



**Fig. 14. Combination Chart.**

Comparison charts have only five distinct forms, but there are many types under each form, since nearly every form permits a wide adaptation. The successful use of a comparison chart often rests very heavily on the proper selection of form, for it is often possible to portray the same problem by distinctly different forms. Briefly, map charts offer the best means of visualization of geographic relationships. Disc-, block-, and bar-charts are commonly used to show component parts. Bar-charts are also used to show relative value or quantity. Curve-charts are reserved exclusively to show relative value or quantity.

**13. (a) Plan charts: organization charts.**—The purpose of an organization chart is to show every essential part of that organization in its proper relation to all other parts. While the most usual application of this form of chart is made to an office, factory, or corporation, it is sometimes used to describe an object. A very well-known object organization chart is that displaying coal and its derivatives. In the office organization chart the source and delegation of authority is indicated, while the object organization chart displays origin and result.

The mechanical devices used to display these features are really only two, namely, enclosed labeled spaces and lines which connect them with each other. When a complex situation is being pictured, the enclosed spaces may be made to assume a variety of shapes. These numerous adaptations have often made it appear that there are more types of this chart than is actually so. In reality, a simple scheme has been disguised by elaborations, the value of which is often doubtful.

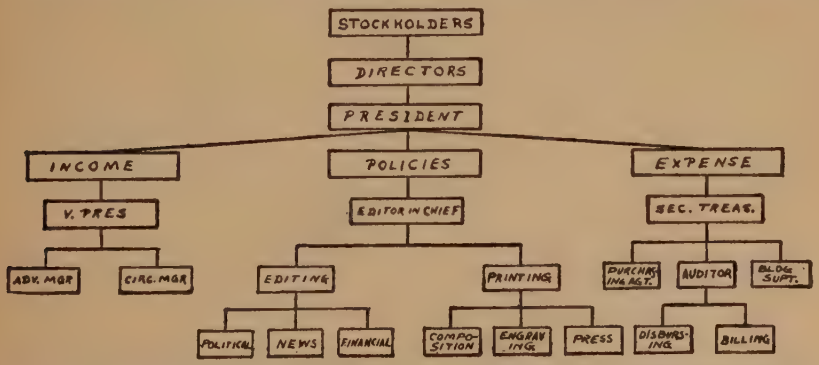



**Fig. 15. Example of an Organization Chart. Skeleton Organization of a Large Newspaper.**

The office organization experts have generally agreed that there are three types of organization methods, each of which should have its particular type of chart display. These three types are: the military plan, which emphasizes concentration of authority; the functional plan, which diffuses authority; and the corporate, line, and staff plan, which has some of the features of each of the first two, in that planners and producers are separated and authority for action is delegated along functional principles, but executed through a military organization. For extended discussion of the merits of these methods, the student is referred to books on office organization.

Before constructing the chart, the use that is to be made of it should be considered. Is the chart to be of a skeleton order, or is it to include every detail of the organization? Is the chart to be a wall chart with a limited number of copies, all made individually, or is it to be duplicated, manifolded, or printed in a reduced size?

The single wall-chart which undertakes to cover completely the whole subject not only permits but may require elaborate and intricate treatment. In such a chart the enclosed spaces may be given different shapes and sizes (explained by the legend) to indicate the nature and importance of any particular service or class of service. The larger the enclosed space, the greater importance may be attached to it, while odd-shaped spaces, easily recognized, though plotted remotely from one another, may indicate a character of service. A thinker, planner, or executive might be designated by disc or oval space, while producing workers might be indicated by rectangles, and distributors or salesmen by triangles. Concentration of high salaries in any part of an organization may be revealed by using a distinctive color on any kind of enclosed space.

Charts that are to be duplicated (as an exhibit in a book or report) do not ordinarily admit, with the same degree of satisfaction, the same detail, but serve best when they represent merely the skeleton of the organization. The wall chart may be said to function like an index digest; to inform with detail as well as to point, while the duplicated chart is like the index alone which merely points.

**14. (b) Plan charts: Procedure charts.**—The purpose of the procedure or flow-of-work chart is to trace the sequence in a series of operations. Often it is difficult to describe a process

without digression, verbal padding, and a succession of "thens" and "nexts." In this way it is difficult to distinguish clearly those steps in a series of operations which are co-ordinate, from those which are in sequence of subordination. Textual or verbal description does not permit the same wordless links between the parts of a whole, and the definite location of a single step in proper relation to the whole.

No other kind of chart, perhaps, permits the same degree of word-paring without loss to clarity, and no other kind of problem is more satisfactory.

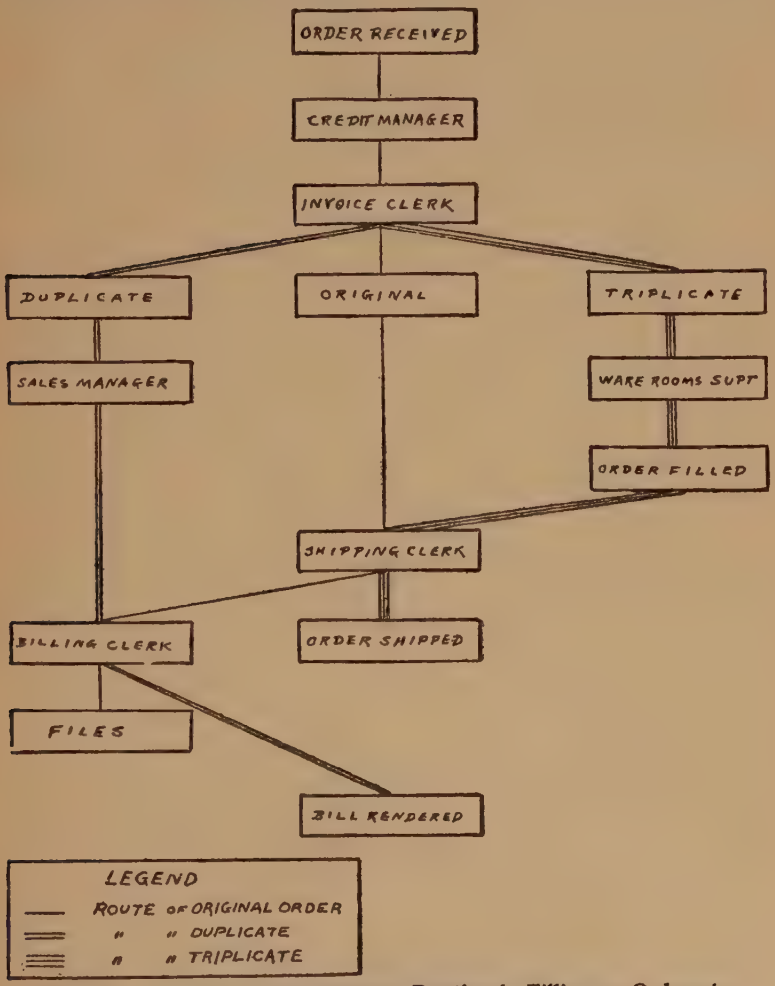



Fig. 16. Procedure Chart Showing Routine in Filling an Order at a Wholesale Establishment.

Mechanically, the usual method of display is to draw rectangles or circular spaces (which are labeled) and connect them by lines which trace the exact relation between the various steps of the process. By visualization of these relationships, confusion is impossible. Sometimes major divisions of a process are designated by larger labeled spaces, thus permitting a glance of the eye to inform the mind more accurately than could many words of explanation.

The top of the chart is the proper place for the source or beginning of the process. Vertical lines (read down) always indicate sequence. Horizontal lines connecting co-ordinate or independent series of actions, which may be carried on simultaneously with the main line of occurrences, and shown in a second vertical arrangement parallel to the first, are used to reveal some inter-relationship. An oblique line, ending with a labeled space, indicates completion of that particular feature of the process.

It is always possible to introduce a more or less simple but perhaps happy device, which by its very design will suggest its own interpretation. For example, if a duplicate or triplicate procedure accompanies an original action (see Fig. 16) the duplicate can be traced by two closely parallel lines, and the triplicate by three lines, the original of course being represented by a single line.

**15. (c) Plan charts: Floor charts.**—Floor charts are merely plans of the floors of offices or shops upon which are plotted to the same scale the furniture and machinery, so that the same physical relationships are shown on paper as exist in fact. The purposes to which these charts are applied differ only slightly, although apparently a variety of problems may be pictured. One type is that which indicates the path or paths of a process which is shown in relief, the office equipment representing only a series of incidents in that process. The other principal type may not emphasize any particular process, but rather show the arrangement of the office or shop, emphasizing good or bad physical relationships of several functions.

The process, plotted on a floor plan, is the one controlling and predominating influence with regard to the desirable location of each piece of furniture; for the most economical method of production is too important to be affected by anything except a physical limitation. The office plan may have other considerations, such as location of high-salaried execu-

tives who, by nature of their duties, require a definite physical location. However, the improper placing of these few may distort the arrangement of other features to a degree that is sometimes far from ideal.

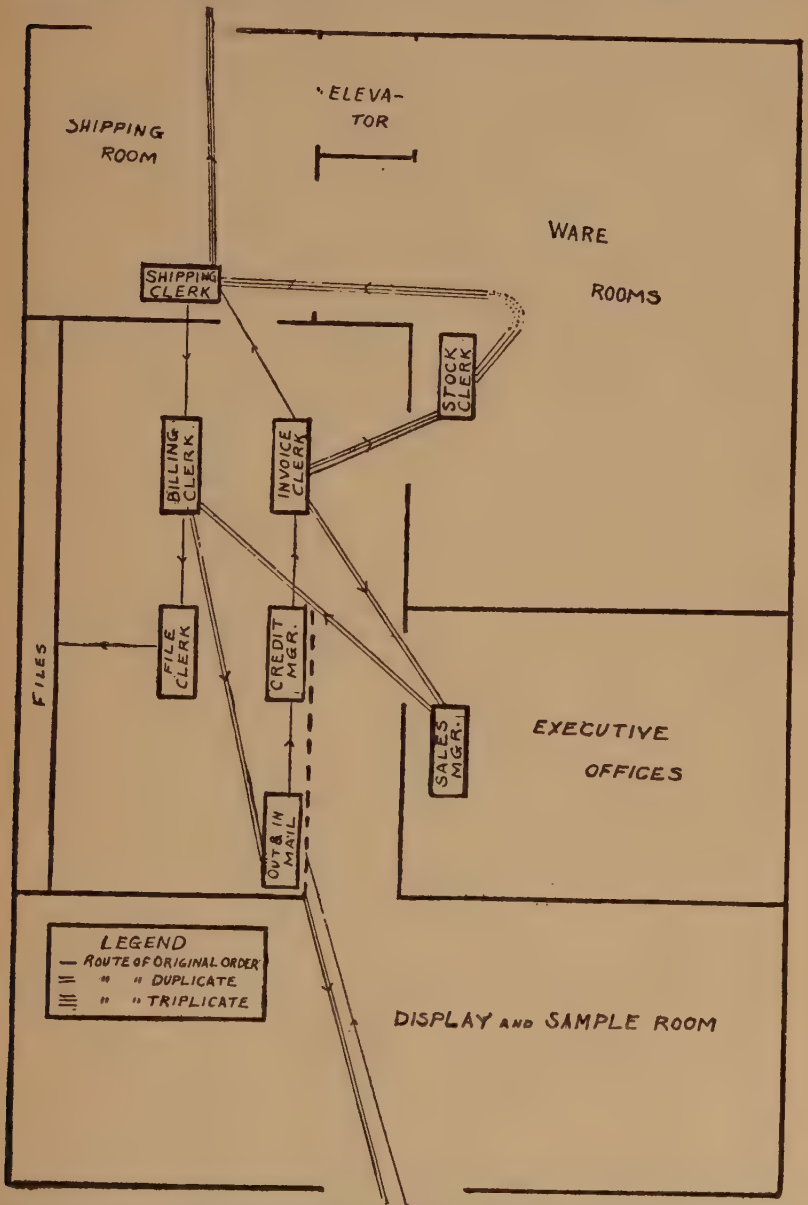



**Fig. 17.** Floor Chart Showing Routine in Filling an Order at a Wholesale House.

Unless a building or quarters are specifically constructed for a particular use, the occupant is obliged to accept the limitations presented, and adapt or compromise until one disadvantage is offset by a distinct advantage at another point. If heavy furniture or machinery is to be installed, it is obvious that the exact space for each piece should be assigned in advance. This may be done by experimentation on paper, where a forefinger may move the paper miniature of a two-ton safe to several widely separated positions as quickly as the eye discovers a place probably desirable for it. Usually there are two sets of fixed conditions: one of a physical nature, such as the location of a window, an elevator, or a chimney, which may not be altered in the least; and the other of a functional nature, requiring a definite location of each feature of the office or process, about which all the rest must be subordinated or related. For example, in a book bindery the finisher's bench must be given the best natural light (usually north in the northern hemisphere), and in a factory or warehouse the shipping clerk must have his quarters at the best location for receipt and dispatch of goods.

The first step in preparing a floor plan is to draw to scale the floor plan of the quarters under consideration, noting the degree of light radiation from windows, doors, skylights, and so forth. Next, to that same scale, all the furniture or machinery should be drawn, preferably on a different-colored paper from that of the floor plan itself, so that when cut out and placed in position the problem of location is thrown into relief. After shifting about this "furniture" until a satisfactory result has been reached, it may be fastened down to or drawn on the plan and then labeled. If a process has been routed, it may be desirable to connect the several points in the process by arrowed lines to indicate direction.

**16. (a) Comparison charts: Map-charts.**—The most effective method of analysis and display of geographic relationships is gained through the use of an outline map upon which may be plotted, by a code, the data of the subject to be described. With maps representing the areas under consideration, one's attention may then be concentrated directly upon the coded information thereon. In a tabular presentation of the same set of facts, it is continuously necessary to check each item with the stub title opposite to which it is set, before one can make any comparison with another item. The transfer of

this data to a map is like combining the title with the item, permitting the user to race from one observation to another without any conscious hesitation in associating the locality with the fact connected with it.

There are two distinct types of map-charts—those that reflect a set of conditions at one stated time and those that illustrate constantly changing conditions. The first may be described as shaded maps, the shading being done by means of colors, cross hatching, or dots. The other general type is the pin, pin and bead, or ribbon map.

Shaded map-charts always represent a statistical study, although that fact may be very much disguised to the casual reader. Colored maps are not as effective as one might imagine, unless the gradations of color from red through orange, yellow and green to blue follow the statistical data in an ascending or descending order. Haphazard assignment of colors to represent the same data would necessitate constant reference to the legend. When this reference is not necessary, then that is one good test of the efficacy of the chart. Reproducing colors is expensive, however, and for that reason other methods of display should be considered first. The cross-hatched map, the development of the statistical basis of the facts to be interpreted, requires first attention. Sometimes it is necessary to follow through two or three processes to reach the desired form for presentation. For example, if the Census reports did not contain tabulations revealing the varying density of population in the United States, it would be necessary to make comparisons of the population of each State with its area. Since that has been done for us, only a rearrangement is necessary before plotting the data on the map. The State having the least or the greatest density of population should head the list and the others follow in an ascending or descending order. Excluding the District of Columbia, the 48 States show 46 different records of density, two pairs of States having the same density. It would be difficult to interpret, as well as to plot, so many records on a single map. For that reason the number of facts to be shown must be reduced to that point which will best permit the maximum absorption, at the same time providing for as many gradations as are necessary to tell the story with reasonable accuracy. Slight variations may be concealed in a narrow group without loss of accuracy, but all the groups should be of even width in order to permit a

proper contrast between groups or between one group and all the other groups together.

**Fig. 18. Outline Map for Recording Density of Population in the United States; 1920.**

POPULATION PER SQUARE MILE PER STATE, 1920
(14TH CENSUS, 1920. V. 1. POPULATION, P. 31)

| | | | |
|---|---|---|---|
| Nevada | 0.7 | Alabama | 45.8 |
| Wyoming | 2.0 | Wisconsin | 47.6 |
| Arizona | 2.9 | New Hampshire | 49.1 |
| New Mexico | 2.9 | Georgia | 49.3 |
| Montana | 3.8 | Missouri | 49.5 |
| Idaho | 5.2 | North Carolina | 52.5 |
| Utah | 5.5 | South Carolina | 55.2 |
| Oregon | 8.2 | Tennessee | 56.1 |
| South Dakota | 8.3 | Virginia | 57.4 |
| Colorado | 9.1 | Kentucky | 60.1 |
| North Dakota | 9.2 | West Virginia | 60.9 |
| Nebraska | 16.9 | Michigan | 63.8 |
| Florida | 17.7 | Indiana | 81.3 |
| Texas | 17.8 | Delaware | 113.5 |
| Washington | 20.3 | Illinois | 115.7 |
| Kansas | 21.3 | Ohio | 141.4 |
| California | 22.0 | Maryland | 145.8 |
| Maine | 25.7 | Pennsylvania | 194.5 |
| Oklahoma | 29.2 | New York | 217.9 |
| Minnesota | 29.5 | Connecticut | 286.4 |
| Arkansas | 33.4 | New Jersey | 420.0 |
| Mississippi | 38.6 | Massachusetts | 479.2 |
| Vermont | 38.6 | Rhode Island | 566.4 |
| Louisiana | 39.6 | District of Columbia | 7292.9 |
| Iowa | 43.2 | | |

Omit the last (D.C.), which is wholly urban and too small to show color or shading on a map. There remain 48 States which vary between 0.7 and 566.4 persons per square mile. These must be grouped just as explained in the section on "frequency series." When possible, uniform intervals should be adopted—or class boundaries. Thus, if six different colors are used on the map, it is possible to have six different groups, with one color for each. A uniform set of group-intervals would be 0-100, 100-200, 200-300, 300-400, 400-500, and 500-600. Obviously, nearly all the States would then fall into the first group and have but one color. This is therefore a case in which uniform intervals for the groups would not be practicable, or of much value.

In such cases as this—and they are very common—it is then best to fall back upon a geometric series for the group-intervals or boundaries—that is, have a constant ratio between each interval and the previous one. Such a set of groups would be "less than 12½, 12½-25, 25-50, 50-100, 100-200, 200 and over." In this case each group boundary is twice as great as the previous one, and we can say roughly that each group is twice as densely populated as the preceding group. Always the determining of the groups calls for the best judgment of the chart-maker. But it should never be attempted to make the groups contain an equal number of items (that is, in this example, States); on the contrary, the groups should have a natural significance of their own.

By the cross-hatching method, not more than ten sets of facts may be displayed successfully on one map, and it is sometimes better not to show more than five or six. The following legend series of ten gradations, as almost a limit of general practice, if applied to this problem will enable one to describe the varying densities of population with greater detail than was done by the Bureau of the Census.

**17. (b) Comparison charts: Dot-maps.**—Sometimes it is desirable to plot the data on the map by means of dots, each dot representing a selected unit of measurement. The result is the dot- or buckshot-map.

Much depends upon the care in selecting the proper unit of measurement, for if the dot is to represent too large a number, the result on the map is unsatisfactory, since the fine variations are concealed. If the number is too small, the task of placing and counting the dots will take too long. In plotting

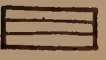
| Legend | OPTION No. 1. States bearing ratios | OPTION No. 1. No. of States | OPTION No. 2. States bearing ratios | OPTION No. 2. No. of States |
|---|---|---|---|---|
| | Under 5 | 5 | Under 2 | 2 |
| | 5 to 24 | 12 | 3 to 4 | 3 |
| | 25 to 49 | 13 | 5 to 8 | 2 |
| | 50 to 74 | 7 | 9 to 16 | 4 |
|  | 75 to 99 | 1 | 17 to 32 | 9 |
| | 100 to 124 | 2 | 33 to 64 | 16 |
| | 125 to 149 | 2 | 65 to 128 | 3 |
| | 150 to 174 | 0 | 129 to 256 | 4 |
| | 175 to 199 | 1 | 257 to 512 | 3 |
| | Above | 5 | Over 512 | 1 |

**Fig. 19. Cross-hatching Methods.**

by dots the population of the United States, a dot for each 1000 population would require 106,000 dots. Usually, also, the dot-map records data by areas smaller than complete States, thus providing for the display of concentration and dispersion at definite points. In New York State, for example, nearly one-half the population is confined to the metropolitan district of New York City, while in the Adirondack region, there is a bare sprinkling.

The best map for charting purposes is a black outline on a white surface, with no unnecessary lines for rivers, mountains, and so forth. The dot-map usually requires a larger map for the first plotting, which will show in dim data detail, the county and sometimes township boundaries. When reproduced on a smaller scale, these lines are often concealed, and the dots, although accurately plotted within smaller geographic divisions, are the only marks within the State boundaries.

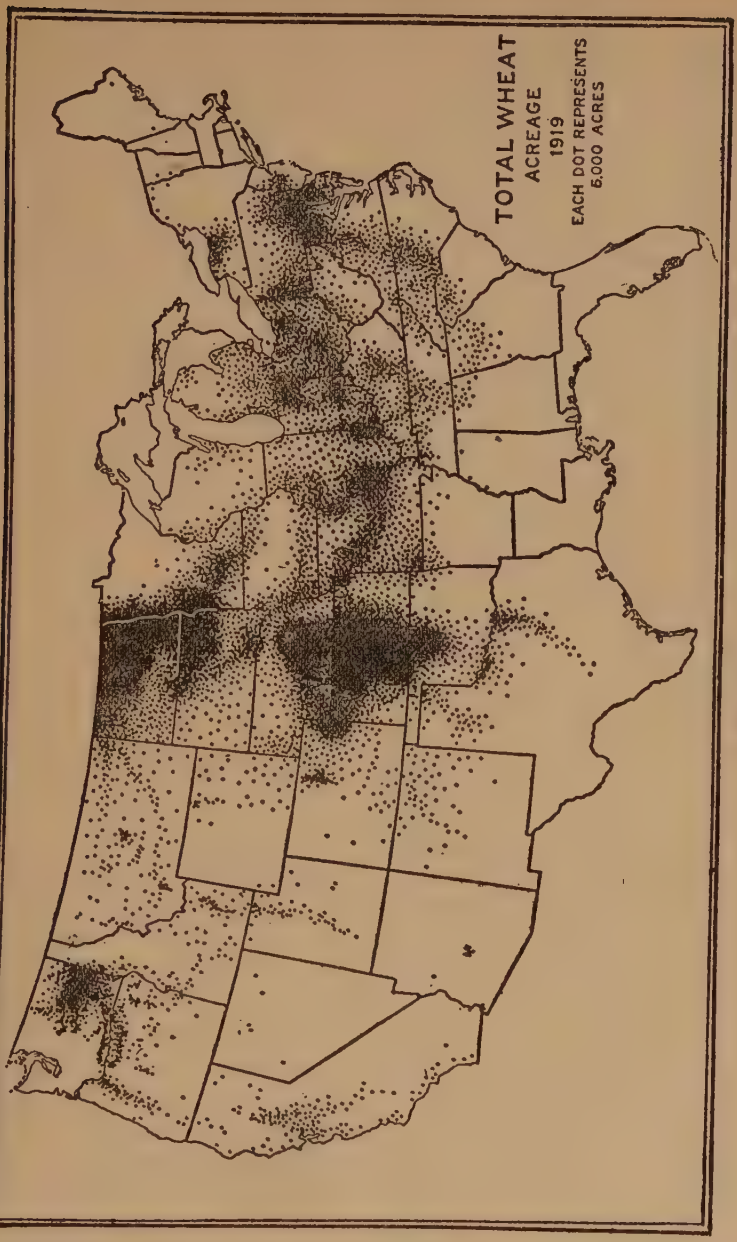



Fig. 20. Dot-map.

Sometimes the dot-map is used by commercial organizations to show the location of branch houses, distributing stations, etc. For this purpose it is permissible to have the dots of different sizes or even shapes to indicate importance.

**18. (c) Comparison charts: Tack- and ribbon-maps.**—The pin-map is merely the map translation of the loose-leaf notebook, which is designed to allow the exclusion from consideration of every item that has not a present or current interest. The removal of a pin or line of pins not only leaves no trace of the previous relations, but allows the next situation to be displayed as if on a clean surface. Business organizations whose operations are conducted on a national scale have found this type of map almost indispensable, for by no other means may so many facts be as quickly visualized.

The map needs to be mounted on a rigid surface, but the material used should be soft enough to permit easy penetration by the tack or pin. Brinton discusses at length the advantages and disadvantages of the pin-map. The Rand-McNally Company has also published a booklet entitled "The World at your Finger Tips," devoted exclusively to the tack-map system. The advertising sections of *System* also list charting supply houses that offer free pamphlets on the subject.

**19. (d) Comparison charts: Disc-charts.**—The disc-, circle-, or pie-chart is used properly to show component parts. It is the most widely used and the most easily read, and in these two facts, perhaps, lie its chief claim for recognition in any discussion of graphics. When considered from every point of view and contrasted with other methods of display, there is little to recommend it.

The circle always represents 100 per cent, thus requiring the percentage translation of every amount to be plotted upon it. If there are many subdivisions, the sectors may be too small to include much of the detail which is necessary to identify them fully, a fact which detracts from the chief value of its use—compression to a single vision. When the eye has to rove from the disc even to a neighboring tabulation, concentration is impaired and quick comprehension is impossible. Such a chart may have splendid instantaneous value, but it does not bear critical scrutiny. A few marked contrasts may be given most emphatic expression, but that is the real limit of its utility.

The sectors are usually lettered or labeled, either with the bare name which they represent, or, in addition to the name, with the amount which is expressed and its percentage of the whole. Sometimes only the latter is indicated, the physical boundaries of the sector, or the exact amount, being sub-

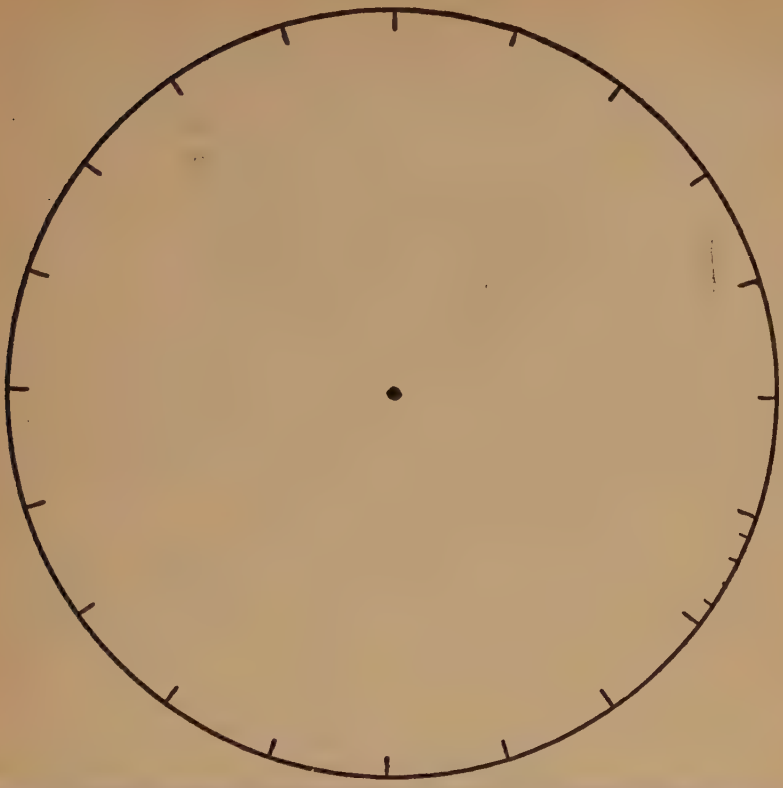


**Fig. 21. Disc Containing 5% Subdivisions, with One Subdivision Showing 1% Divisions.**

ordinated to its per centum equivalent. In either instance, the exact or the relative volume of any part cannot be more than approximated. The arrangement of lettering is awkward, no matter how neatly it may be executed. If, to meet the requirement "that every item be lettered so as to be read from one position," the lettering is lined parallel to the bottom of the chart, the varying sizes of some sectors may be filled to overflowing while others are almost void of marking. The result is bound to appear uneven. If the lettering always begins at either the center or the circumference, then some of the inscriptions must be read upside down. The third possible arrangement, which on the whole gives the best result, requires the reversal of lettering, some of the inscriptions reading from the center and others from the circumference.

The most usual application made of the disc-chart is that of delineation of budgetary problems. One of the most

widely-exploited instances of this use is the "Swift Dollar," an advertisement by a large meat packing company which aims to show the exact disposition of every dollar of its business income.

**Fig. 22. A Typical Example of the Disc-chart, in the Form of the Famous "Swift Dollar."**

The use of two or more undivided discs of different sizes to represent varying bulks or values is contrary to the best practice, the rule being to represent bulk or value by linear rather than by area measure.

The detail of construction is very simple in theory, but the exact mechanical application of that theory is difficult unless one has more than the ordinary desk equipment. After drawing the circle, the circumference should be lightly marked into one hundred equal parts. The point of the circle that is "twelve o'clock" should be the starting point, and in plotting, the direction followed should be that of the hour hand.

**20. (e) Comparison charts: Block-charts.**—The block-chart derives its name from its form and serves best to display component parts. This chart provides the best medium for describing complex and multifarious internal relationships, for it permits compression of a mass of detail to a single focus of vision. While the best visual effect is secured by making the block a perfect square, a nearly square rectangle is more often used because of greater ease in constructing it and plotting part of the detail to be included. The chart is read by two dimensions, the vertical scale usually measuring the total volume represented, while the horizontal scale equals 100 per cent.

The best exposition of both construction and interpretation is afforded by application of a particular problem to this form of chart. The appended tabulation represents the organization of an establishment, divided departmentally, which performs several classes of work calling for different grades of service, varying in proportion according to those departmental subdivisions.

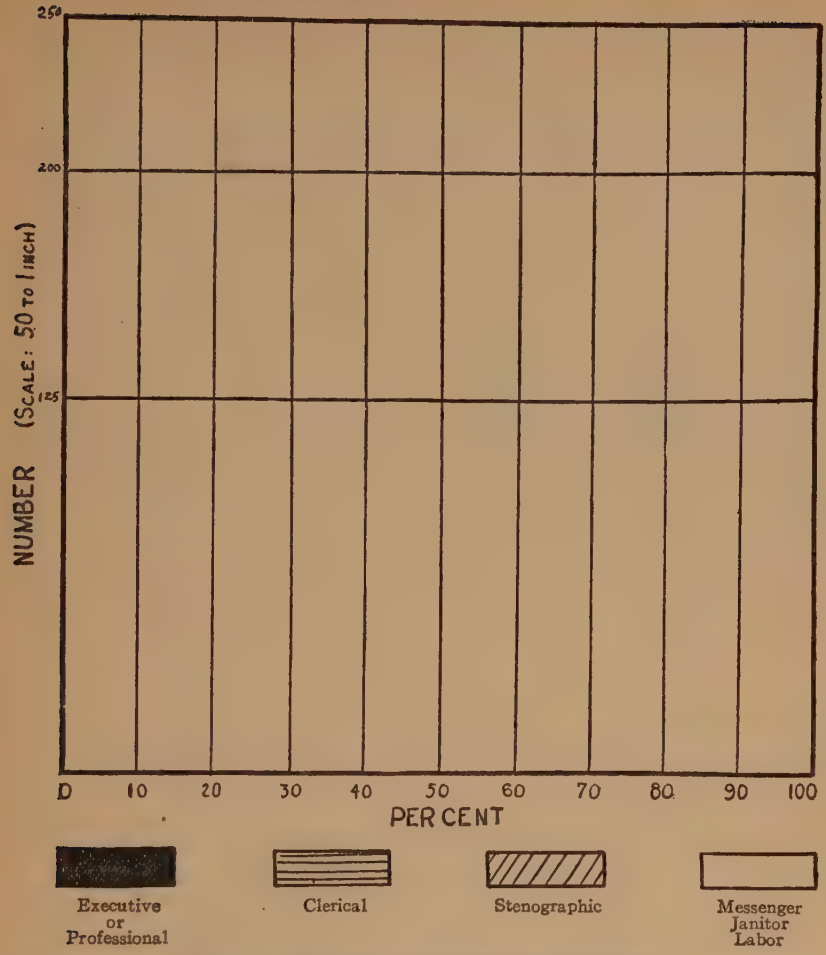



**Fig. 23. Background for Block-chart Problem.**

BLANK PUBLIC SERVICE BUREAU

| *Divisions* | *Total Workers* | *Executive or professional* | % | *Clerical* | % | *Stenographic* | % | *Messenger* | % |
|---|---|---|---|---|---|---|---|---|---|
| Totals..... | 250 | 126 | *50.4* | 71 | *28.4* | 37 | *14.8* | 16 | *6.4* |
| Administrative..... | 50 | 8 | *16.* | 16 | *32.* | 18 | *36.* | 8 | *16.* |
| Legal research..... | 75 | 68 | *90.6* | 0 | *0.* | 4 | *5.3* | 3 | *4.2* |
| Industrial research... | 125 | 50 | *40.* | 55 | *44.* | 15 | *12.* | 5 | *4.* |

Draw two lines perpendicular to each other. First, the scale of measurement for the vertical line, which will show the total number of persons in the organization, must be determined. Let one inch represent 100 persons. The vertical line

is then two and one-half inches high. Starting at the intersection (representing zero) lay off one and one-fourth inches to represent the number of workers in the Industrial Department. Three-fourths of an inch higher marks the 75 in the Legal Department, leaving one-half inch to represent the 50 in the Administrative Department. Lay off on the horizontal, in a distance equal to the vertical plotting (two and one-half inches) ten equal parts. Each division will represent 10 per cent of that line. This scale is divided into per cents because the number of workers in each department varies and yet must be represented by the same length of line. The character-of-service figures must therefore be translated into percentages before that data may be plotted.

After the amounts have been plotted, the resulting segments should be cross-hatched in accordance with a selected legend.

Fig. 24. Example of Horizontal Bar-chart.

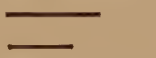
21. (f) **Comparison charts: Bar-charts.**—Bar-charts are the easiest to make with the greatest accuracy, and are capable

of the most universal application of any of the forms of comparative charts. They provide the simplest form of comparison, and are nearly always preferable to either the disc- or block-charts, even for the display of component parts. After a unit of measurement ($5 or 5 feet — ⅛ inch) has been selected, the figures of the tabulation to be represented are merely translated from numerical to linear form.

The bar-chart may be of the single or multiple variety. In either instance of use, the bar may be subdivided and cross-hatched (see legend for cross-hatching on page 54, under discussion of the map-chart). The bars may be arranged either vertically or horizontally, but the sequence of the items is actually more important than position. The horizontal is generally preferred to show cross-section or frequency data, while historical data is best displayed in a vertical position, but the sequence of arrangement should always show the

earliest at the left, 1890 1895 1900 1905 or, when

time is not a controlling feature, the largest or most favored at the top



or left

Adherence to these rules makes it possible to read the chart either from left to right or from bottom to top. The scale should be shown at the left or bottom.

The bars should be of uniform width and be evenly spaced. When there is a large number of items, lines may be used instead of bars. For ease of construction, it is often desirable to make the initial chart on co-ordinately ruled paper, but the finished result appears to the greatest advantage if transferred to plain white paper, retaining only those lines that will aid in the rapid interpretation of the chart.

The title should be placed at the top, and sub-titles adjacent to the parts to which they apply, but the legend may be placed where the greatest ease of reference is afforded. The inclusion

of the statistical tabulation, upon which the chart is based, always adds authority and is frequently desirable.

In 1915, approximately 440,000,000 tons of bituminous coal were consumed in the United States. The tabulation below tells how it was consumed, and the charts illustrate the data.

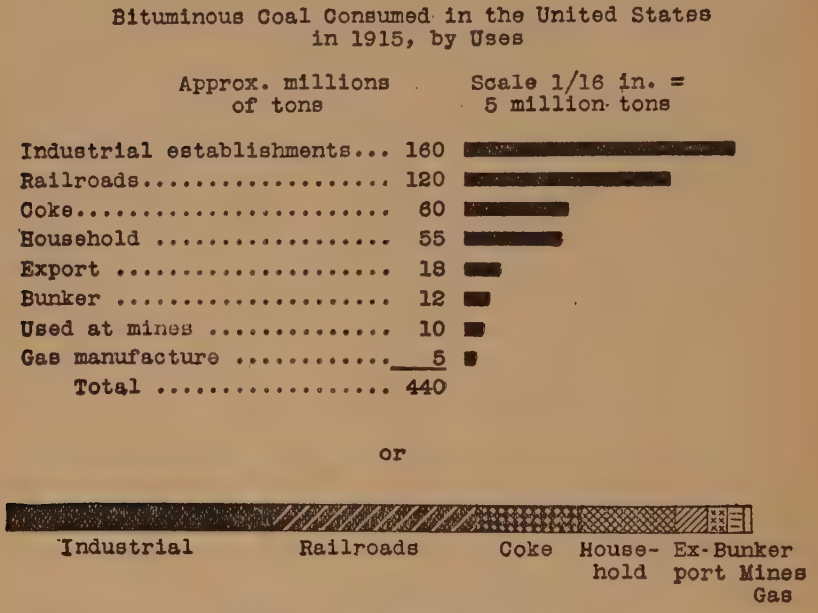



Fig. 25. Two Types of Bar-charts.

The National Industrial Conference Board has for a number of years published a periodical analysis of the cost of living (a retail price study). It has taken 1913 as base year, $1, equaling 100 per cent, and has interpreted each succeeding period in terms of the expenditure of that 1913 dollar. As a result, the following index numbers were arrived at:

| | *Index Numbers* | | *Purchasing Power of $* |
|---|---|---|---|
| 1913 | 100 | | $1.00 |
| 1914 | 102 | | .99 |
| 1915 | 101 | | .99 |
| 1916 | 114 | Which would make the purchasing dollar equal | .87 |
| 1917 | 146 | | .68 |
| 1918 | 168 | | .59 |
| 1919 | 203 | | .49 |

This may be shown by a bar-chart which begins with a standard bar and increases the length of each succeeding bar

if the index figure is to be used, or decreases the length of the bar if the dollar-value number is exploited.

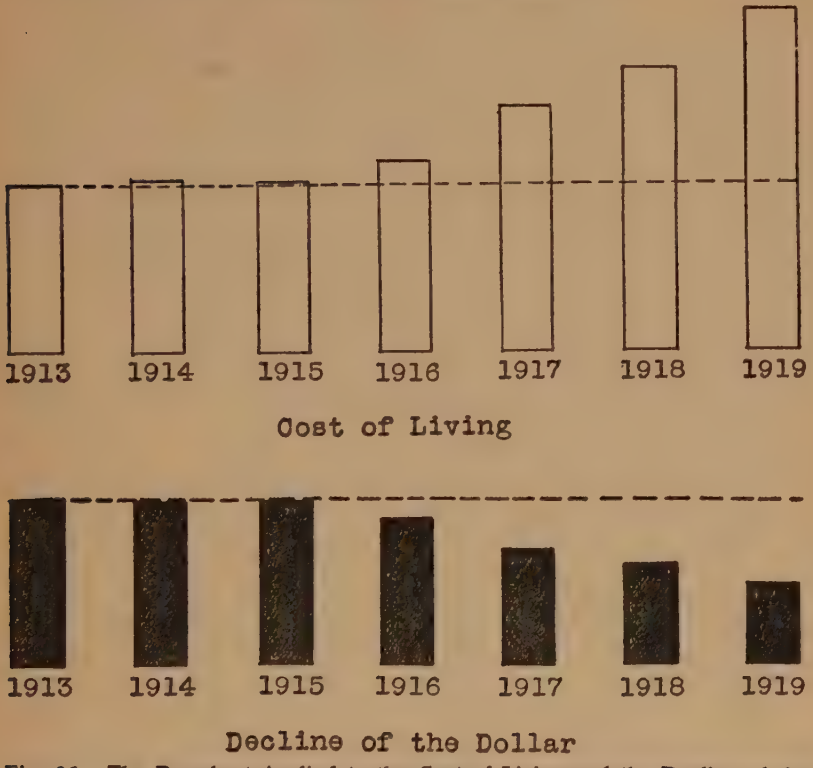



**Fig. 26. The Bar-chart Applied to the Cost of Living and the Decline of the Dollar.**

The solid portions of the bar represent the decline in purchasing power of the dollar. The extended outline of those bars indicates the increase of price as represented by index numbers.

Sometimes the bar-chart is more effective if the bars are displayed in a compressed form as shown by the chart on page 60, which is an ideal example of inclusion of a mass of detail and its statistical basis. The Cleveland Trust Company in its Business Bulletin for February 15, 1922, has used this chart, after slight conversion, and introduced an outline indicating the course of wages over the same period. The transition of the bar-chart into a flat-top curve-chart should be studied carefully.

22. (g) **Comparison charts: Arithmetic curve-charts.**—Curve-charts properly presented generally enable one to interpret figures better than any other method of statistical presentation. These charts are easily made and frequently can be used to better advantage than other forms of charts.

Some discussion of the co-ordinately-ruled paper, which forms the mechanical basis of curve-chart construction, is necessarily preliminary to any detailed study of the chart itself. This paper, with many varieties of rulings, may be purchased at almost any stationer's at a low cost. For most purposes, however, it is generally preferable to rule the paper as required when making arithmetic curve charts. The labor involved is usually slight and the rulings can be made to conform to the space limitations, if any, and also to fit the data to be charted. In drawing the co-ordinates, the rules for graphic presentation (see p. 23), particularly rule 9, should be kept in mind.

It is possible by means of arithmetic curve-charts to show the same data in such a way as to convey radically different *visual* impressions. These visual effects are produced by using different spacing in ruling the paper. If, for example, the vertical lines are a quarter of an inch apart and the horizontal lines half an inch apart, the visual effect will be totally different from that when the spacing arrangement is reversed. Still another visual impression is given when the spacing is the same. In charting it is frequently desirable to make the three differently-spaced rulings, plot the data on each, and then select the form best showing the problem and also meeting any limitations as to space. These three charts need be drawn only roughly.

Fig. 27 shows one specimen of arithmetic curve paper, although not revealing the narrower rulings to be found on most curve-chart paper, but it will serve to show the use made of the ruled lines. The perpendicular and horizontal lines merely form the back-ground of the curve-chart and serve only as scales of measurement. One feature (in this instance, number of failures), is measured vertically, and another feature (time), horizontally. The "curve" is actually formed by a series of straight lines connecting the points of observation that are plotted on the scales. These straight lines, however, when viewed in perspective, often have the appearance of curves. Thus it may be said that the curve-chart derives its name from the general visual effect produced by

the line which registers statistical data, plotted to selected scales, on a co-ordinately-ruled background.

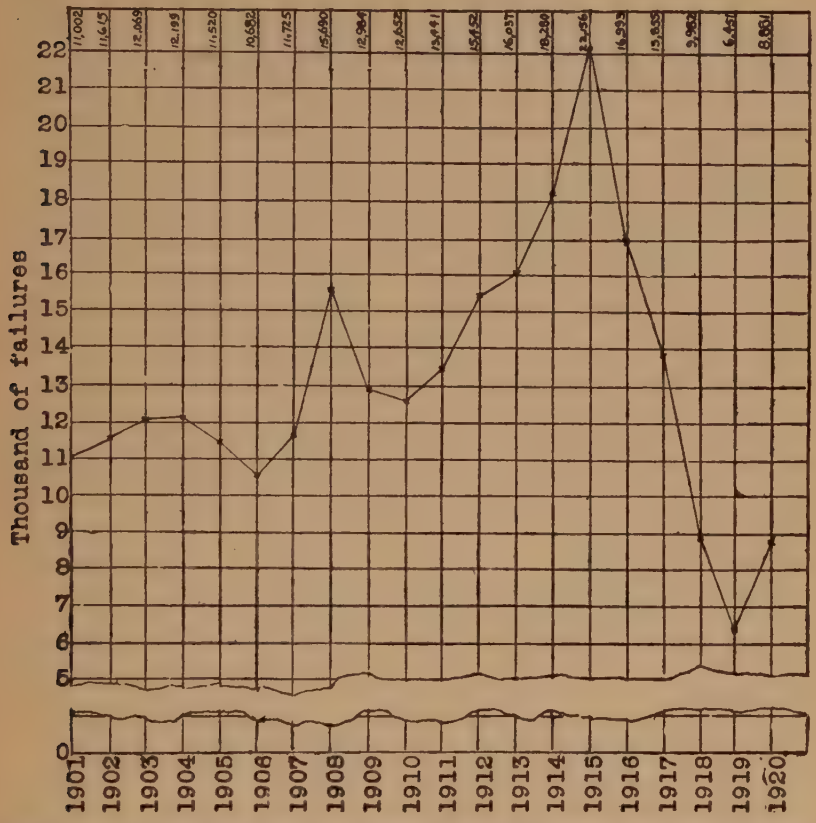



**Fig. 27. Curve-chart Showing Number of Business Failures, 1901–1920 (Dun's).**

Plotting statistical data on this chart consists in making dots opposite the corresponding number on the vertical scale and the corresponding date on the horizontal scale. It may be observed from the diagram that each square horizontally represents a year, while each square vertically represents one thousand failures. The plotting in this instance was made on the right-hand edge of the square, because the figures were the total for the completed year. Had the figures represented year averages, then the horizontal middle of each square might have been the preferable spot for marking the observation. After all the observations were made and carefully checked to insure accuracy, the points representing them were connected

to bring out in strong relief the course of the data through a period of years.

The plotting by points and their connection by straight lines gives an effect that is styled a "peak-top" curve. For this particular problem the observation might have been shown by a horizontal line clear across each square. The con-

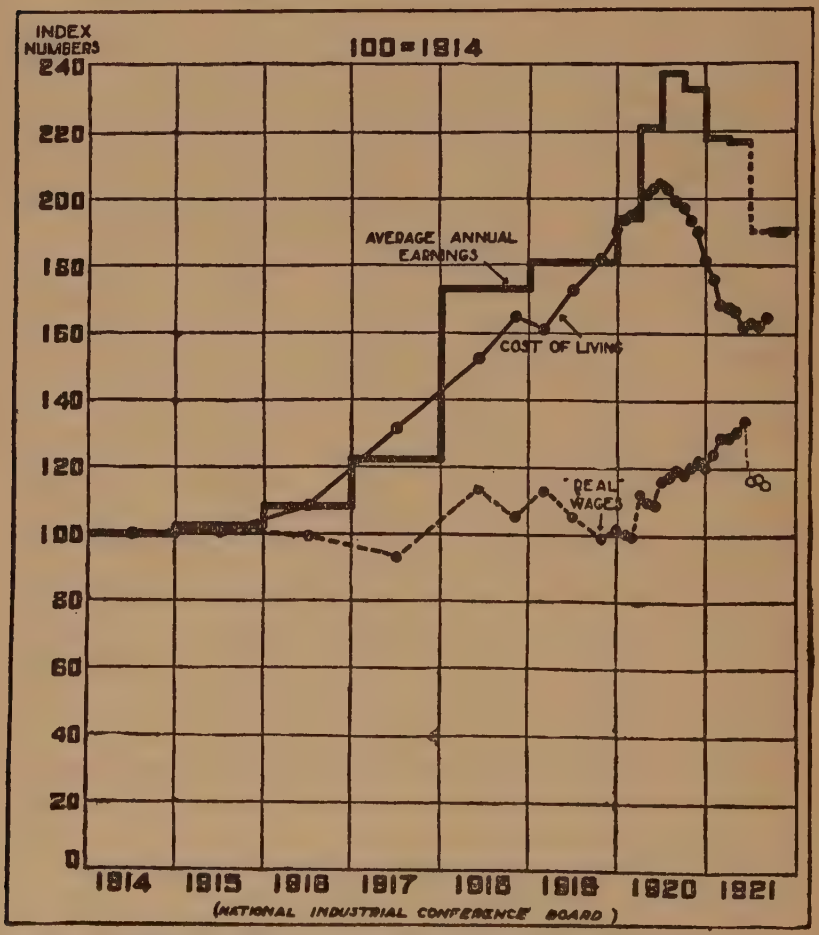



**Fig. 28. Peak-top and Flat-top Curve-chart Showing Railroad Wages at a Glance.**

Average earnings of employes of class I railroads and cost of living, 1914-1921. The estimate of earnings from July to September, 1921, is based on a 12½ per cent average wage cut, and assumes the same working time as in the previous period. The line "real wages" represents how much better off, from the standpoint of earnings over expenditures, the railroad employes were at the specific periods.

nections between the points of observation then would have followed the vertical scale lines, and the effect would have been styled a "flat-top" or "stair-case" curve. Each method has its special merit, but when a number of series of facts are recorded on the same chart, there is less confusion if the peak-top curve method is followed, since each curve line is distinct from any other, although the curve lines may cross one another a number of times. Wages, however, which are ordinarily likely to remain static for longer periods and then change abruptly, are better recorded by the stair-case curve. Prices, which have a habit of almost continuous fluctuation, are better displayed by the peak-top curve. An unusually good illustration of these principles may be found in the *Iron Trade Review* for November 3, 1921, p. 1162, which contains a chart giving the route of wages and prices.

The break in the chart, near its base, indicates an omission of five vertical squares which are not affected by plotting of the statistical data, and their omission saves space. This illustrates rules 3 and 4 on p. 23.

In most charts for ordinary purposes, the vertical scale is used for quantities or amounts and the horizontal scale for time, as in Fig. 27. If, however, it is desired to compare data similar to the following, the horizontal scale would not be used to show time.

NUMBER OF DEFECTIVE MACHINES PER 1000 BY SPECIFIED AGE-GROUPS FOR 1910 AND 1920

| | *No. per 1000 persons* | |
|---|---|---|
| | *1910* | *1920* |
| Less than 2 years | 38 | 35 |
| 2 to 4 years | 36 | 30 |
| 4 to 6 years | 32 | 27 |
| 6 to 8 years | 25 | 20 |
| 8 to 10 years | 23 | 15 |
| 10 to 12 years | 19 | 11 |
| 12 to 14 years | 12 | 5 |
| etc. | | |

In plotting the above, the vertical scale should be used to show the number of occurrences per 1000 persons, in this case in steps of 5, and the horizontal scale should represent the age-groups, the "less-than-2-years" group being placed at the left. The number of occurrences per 1000 persons in 1910 and 1920 are then plotted in the form of curves, using a broken or light line for 1910 and a solid or heavy line for 1920.

**23. Comparison charts: (h) Logarithmic curve-charts.**— The type of curve-chart discussed in the foregoing pages is called an "arithmetic" curve-chart because equal numerical differences are shown by equal physical differences between the vertical and between the horizontal co-ordinate rulings. Such charts are primarily for comparing quantities, and serve this purpose admirably when the quantities or things to be compared are approximately the same in size or value. When, however, it is the ratio-of-change or percentage fluctuations which are to be shown, the arithmetic curve-chart method is likely to be misleading and the "logarithmic" or ratio-chart should be used.

The rulings for ratio-charts are drawn on a logarithmic scale, which, as the lines ascend the scale, show each additional measurement in proportion with all the lesser measurements, and so afford a more accurate picture of relative ratios and changes. It is not necessary to have even a superficial knowledge of logarithms to construct or interpret problems on this type of chart, for having the lines already drawn, the method of plotting is the same as with the arithmetically-ruled surface. If this fact were generally appreciated, many situations that have been displayed by arithmetic charts would have been drawn on a logarithmic scale.

The chief thing to be held in mind by those without a knowledge of logarithms is that logarithmic chart-making and reading is not one bit different from the making and reading of arithmetic curve-charts except in the character of the ruling. If it is desired to read the values of the different points on a curve-chart, the scale is entered on both the arithmetic and the logarithmic charts. The trend of curves also may be followed with equal facility on either the logarithmic or arithmetic charts.

While logarithmic rulings may be made as needed by using a slide rule, most stationers carry a variety of logarithmic ruled paper which can be purchased at a slight cost. It should be remembered that there is no zero line on the ratio paper, and that zero cannot be plotted upon such charts. Likewise no negative members can be plotted on a ratio chart in which positive members are shown. But these and many other details the student will learn better with a little experience and practice with the chart.[1]

[1]For discussions of the ratio-chart, read articles by Fisher and by Bivins referred to on page 103.

Marshall, in his "Graphical Methods," states the difference between ratio and arithmetic curve-charts clearly and concisely. In substance he says: "The contrast between the ratio and the ordinary difference diagram is simply one of spacing, the ratio method having the numbers 1:10, 100:1000 equally spaced.". The two charts shown in Fig. 29, orig-

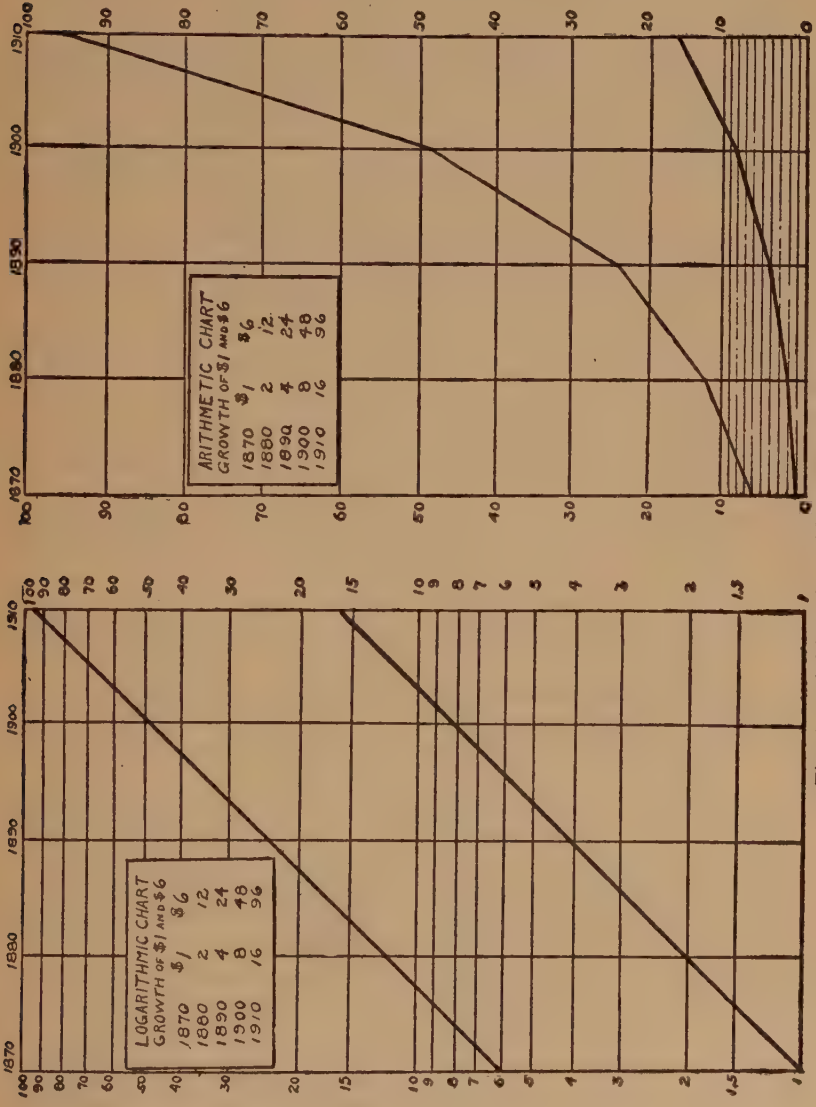



Fig. 29. Arithmetic and Logarithmic Charts.

inally drawn by John Wenzel for the *Scientific American*, April 14, 1917, are there commented on as follows: "The growth of $1 and $6 when placed at compound interest for forty years does not look the same in the arithmetic chart although the percentage is the same and so appears in the logarithmic chart as the lines of growth are parallel." The arithmetic method gives a distorted picture of the problem, while the logarithmic method displays it accurately.

A further proof of the increased accuracy of representation provided by the logarithmic chart may be found by plotting the following tabulation of decennial population returns of the United States from 1790 to 1920 in both types of charts.

POPULATION OF THE UNITED STATES
DECENNIAL PERIODS, 1790 TO 1920

| | *Official* | *Round millions (last 6 ciphers omitted)* |
|---|---|---|
| 1790 | 3,929,214 | 4 |
| 1800 | 5,308,483 | 5 |
| 1810 | 7,239,881 | 7 |
| 1820 | 9,638,453 | 9 |
| 1830 | 12,866,020 | 13 |
| 1840 | 17,069,453 | 17 |
| 1850 | 23,191,876 | 23 |
| 1860 | 31,443,321 | 31 |
| 1870 | 38,558,371 | 38 |
| 1880 | 50,155,783 | 50 |
| 1890 | 62,947,714 | 62 |
| 1900 | 75,994,575 | 76 |
| 1910 | 91,972,266 | 92 |
| 1920 | 105,710,620 | 106 |

The curve in the arithmetic-chart will make it appear that a decennial increase of the population in the fifties bears a ratio different from that existing in an increase fifty years later. The curve on the logarithmic-chart will indicate accurately each decennial increase as it truly affects the total population. In 1790 a sudden increase of ten million in population would have had a tremendous effect, while 130 years later the same increase would be absorbed readily, naturally, and without unusual effect on the country. The proper type of chart to portray these occurrences will present accurately the true nature of the change.

The best practice in the case of important statistics which can be presented by curve-charts is to use both the plain and the ratio methods, making two charts for the same data and presenting them side by side. The plain or arithmetical curve-chart will afford a true picture of quantities and the amounts of changes, but will be misleading as to the rates of changes. The ratio or logarithmic curve-chart will afford a true picture of the rates of changes, both from time to time and in comparing different curves, but will fail absolutely to show quantities or amounts. Thus the two supplement each other, and each serves an important purpose without being misleading in other respects.

**24. Pictogram.**—The term "pictogram" may be applied to any form or type of chart which has been disguised, distorted, or converted in any way for the purpose of securing

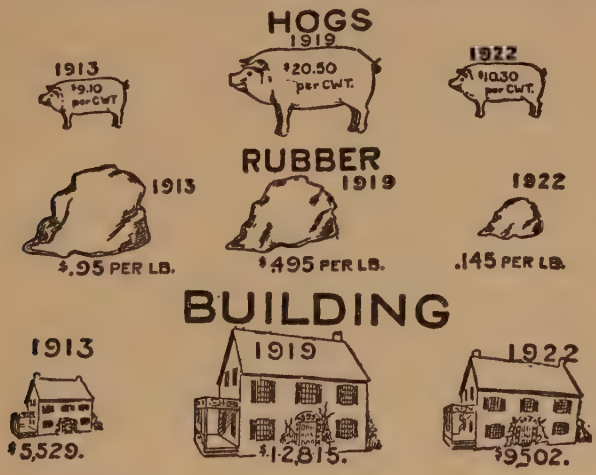



**Fig. 30. Pictorial Record of Price Movement.**
*(Boot & Shoe Recorder)*

greater popular appeal. Many of the fundamental principles of standardization, good practice, and accuracy are often disregarded in their construction. The purpose of this popularized chart is to gain more surely the instantaneous attention of the eye and then lead it to the adjacent text. The pictogram is actually a picture, with just enough detail of form to suggest, or even assert, that it is based upon careful and minute observation.

Analysis of a large number of pictograms has indicated that, actually, each one may be reduced to some one of the eight

forms outlined in Paragraph 12 and expanded upon in the following paragraphs. The disc, with its sectors illustrated by insert pictures of a bed, a dining table, and an automobile, for the purpose of telling without words how one person's time is consumed, is still a disc-chart. The picture of the Washington Monument at the left side of an advertisement and another picture of a single tier of shirts at the right is actually a bar-chart, even though the lowest shirt in the pile is inaccurately represented as covering as much ground as the base of the monument. While obviously inaccurate, the professional advertiser might call it, even as a chart, highly effective. The picture of a small barrel of oil beside a huge pile of coal, with adjacent text representing the heat and power value of the two as equal, cannot be anything but a block-chart.

It is to be noted in Fig. 30 that the pictograms represent quantities by areas or volumes. The second house appears to be more than twice the size of the first, and yet it was intended by the artist to represent a quantity only about twice as great. To be exact, if the reader judges by the surfaces covered by the two pictograms mentioned, he will conclude that the second house, covering four times as much paper, represents a quantity *four* times as great. If he judges by the volumes indicated by the two houses, he will think the second eight times as great. Such charts are therefore misleading, and the student is strongly urged to use the bar-chart in making comparisons of this kind. It is often possible, in fact, to use an illustration to catch the eye, with a bar-chart drawn in the proper proportions alongside.

Another good example of a misleading pictogram is the one which is often used to show the relative sizes of two armies. We will assume that one army is four times the size of the other. To illustrate this fact, two soldiers are presented, the first supposedly one-quarter as large as the second. Obviously, accuracy of presentation is impossible. The correct method of constructing a pictogram of this sort is, of course, to let the first army be represented by one soldier, and the second by four soldiers, *all five being drawn exactly the same size.* Such a pictogram combines attraction-value with absolute accuracy of proportion, and contains all the advantages of the bar-chart.

## Problems

1. Describe fully the relations of the parts in Fig. 14.
2. What is the especial attribute of the disc-chart?
3. What is a bar-chart?
4. What is the especial value of cross-hatching?
5. For what purposes are dot-maps chiefly used?
6. What is it that often makes a pictogram misleading?
7. Put the following data in graphic form, selecting the type of chart you believe best suited to appeal to the general public, and state your reasons for making the selection.

DISTRIBUTION OF COST OF MANUFACTURING
BLANK STOCK FEED PER TON IN 1920

Labor, $10; raw materials, $30; power, $6; miscellaneous, $4

8. Make a block-chart of the following:

DISTRIBUTION OF COUNTRY GRAIN ELEVATORS
BY TYPES IN SPECIFIED STATES

| *State* | *Total* | *Line* | *Mill* | *Co-operative* | *Independent* |
|---|---|---|---|---|---|
| North Dakota..... | 1500 | 700 | 100 | 400 | 300 |
| Minnesota..... | 1200 | 500 | 150 | 300 | 250 |
| South Dakota..... | 1000 | 300 | 100 | 400 | 200 |
| Montana..... | 500 | 275 | 50 | 125 | 50 |

9. What form of chart would you use for showing the following:

Red 40%, White 30%, Blue 15%, Green 10%, Yellow 5%, Total 100%.

10. Show the following data in the form of an arithmetic curve-chart:

COMPARISON OF PROPOSED PRODUCTION OF BLANK AUTOMOBILES WITH ACTUAL PRODUCTION BY MONTHS, TOGETHER WITH THE CUMULATIVE PROPOSED PRODUCTION AND THE CUMULATIVE ACTUAL PRODUCTION

| *Month* | *Proposed Monthly Production* | *Cumulative Proposed Production* | *Actual Monthly Production* | *Cumulative Actual Production* |
|---|---|---|---|---|
| January | 100 | .... | 25 | .... |
| February | 125 | 225 | 50 | 75 |
| March | 125 | 350 | 60 | 135 |
| April | 150 | 500 | 110 | 245 |
| May | 160 | 660 | 140 | 385 |
| June | 175 | 835 | 160 | 545 |
| July | 190 | 1025 | 185 | 730 |
| August | 200 | 1225 | 195 | 925 |
| September | 225 | 1450 | 220 | 1145 |
| October | 250 | 1700 | 250 | 1395 |
| November | 275 | 1975 | 280 | 1675 |
| December | 300 | 2275 | 300 | 1975 |
| | 2275 | | 1975 | |

11. Put the following in the form of an arithmetic curve-chart:

NUMBER OF DEFECTIVE MACHINES PER 1000 BY SPECIFIED AGE-GROUPS FOR 1910 AND 1920

| *Age Groups* | *No. of Defective Machines per 1000* | |
|---|---|---|
| | *1910* | *1920* |
| Less than 2 years | 8 | 5 |
| 2 to 4 years | 12 | 6 |
| 4 to 6 years | 10 | 8 |
| 6 to 8 years | 16 | 14 |
| 8 to 10 years | 18 | 20 |
| 10 to 12 years | 25 | 25 |
| 12 to 14 years | 32 | 28 |
| 14 to 16 years | 47 | 36 |
| 16 to 18 years | 43 | 38 |
| 18 to 20 years | 50 | 41 |

## Part Three

# THE USE OF GRAPHS IN ACCOUNTING AND BOOKKEEPING

## Chapter VI

# HOW TO PRESENT ACCOUNTING FACTS

**25. What accounting is.**—Accounting is the science which deals with the recording, verification, and presentation of financial facts. Bookkeeping is generally conceived of as the actual work of recording facts in books of account. Whether one is working as bookkeeper or accountant, the business facts must be entered properly in adequate and carefully designed books, the work must be proved, and the results and condition of the business as set forth in the records must be brought to the attention of those who own and manage the business.

Because this is a discussion of the use of graphs rather than a treatment of accounting as such, we will not concern ourselves with the recording and verification of facts. Our problem is this: Assuming facts to be correctly and adequately recorded, how may we present these facts to the executive and owner so that the most important ones will stand out clearly?

**26. The purpose of accounting.**—Years ago, the accountant or bookkeeper was looked upon by business men generally as non-productive—a sort of necessary evil. Books had to be kept in order to know who the debtor customers were and how much they owed the business. Records might also be made to indicate how much the business owed to others. Of course, this was secondary—it is never as interesting to know how much we owe as to know how much others owe us. The very progressive business man might also keep a record of cash—although as knowledge of the amount of cash on hand was obtainable by actual count, many enterprises considered cash records superfluous.

The point of view of modern accounting is very different. With a slight stretch of the imagination we may look upon the accounting department as a manufacturing plant, having as its product, information, and having as its machinery, the

host of records and books in which facts are entered and classified. Just as in a real manufacturing plant it is necessary to have a clear view of the product to be made before designing or installing the machinery, just so the present-day accountant must first make a study of the nature and quality of the information to be presented.

The accountant will find that the information to be presented will vary with (a) kind of business, (b) size of enterprise, (c) mental type of those who are responsible for its conduct. But regardless of these, he will have in mind that there are two types of information that every business owner and manager needs—needs because wise planning for the future must be based on sound knowledge of the past.

**27. The two classes of information furnished by the accountant.**—Every business man, large or small, needs to know accurately facts concerning values possessed by him. He needs also full and complete information of his obligations to pay out values to his creditors. His values are spoken of as his assets. Obligations are generally referred to as liabilities. The facts concerning assets and liabilities which he has at a particular moment of time are known as facts of *condition*. These constitute one of the two great groups of facts which a business man or manager must have. A full detailed discussion of how graphs may be used to present facts of condition will be found in a later chapter.

Clearly a knowledge of one's financial *condition* is important. But of equal importance is a knowledge of one's financial *progress*. Business exists to render a service for a *return* which should exceed the total *cost* and leave a margin commonly known as *net profit*. Information as to the amount of net profit and the causes which produced it is of real interest to the one who may thus read the history of the business past, detect mistakes, select those acts which were productive of income, eliminate those which were harmful and thus have a basis for judicious planning for future success.

**28. How to present facts.**—The time-honored method of bringing information to the attention of owners and managers is by the use of carefully arranged groups of figures, commonly called statements. A great deal of effort has been expended in developing statement forms which will present business facts effectively.

While various types of statement have been found useful, the principal statement expressing condition is the Balance Sheet. The principal statement which shows progress has many forms and several distinct names, the most common of which are Income Statement, Revenue Statement, and in trading and manufacturing concerns, Statement of Profit and Loss.

By skillful arrangement, precision in the use of terms and judgment in choice of type, rulings, inks, and other material elements, statements may be prepared which show with accuracy the several vital facts of business.

It is generally true, however, that in business we are concerned less with *facts* than with the *relation* of certain facts to others. The amount of total assets is important, but its relation to total liabilities is even more important. The amount of cash on hand is vital, but its relation to the amount of indebtedness due and overdue is, after all, the more interesting fact.

In some measure, skilled statement-design may bring out relations. Certain groups of items, for example, may be so placed as to make them very easily compared. But even the most expert arrangement of figures in statements may prove ineffective in bringing out clearly and forcefully business relations of prime importance and great significance.

Exact amounts are best shown by figures—relations may be most clearly shown by pictures. The graph is a form of picture. It will be our chief purpose in the succeeding pages to indicate the use of graphs in presenting facts of a financial nature.

## Chapter VII

# GRAPHIC PRESENTATION OF FACTS OF FINANCIAL CONDITION

**29. Facts of financial condition.**—The amount of cash one has, the amount John Doe owes the business, the total amount due others on account of notes, the amount of merchandise on hand, present value of furniture and fixtures—these are a few of the facts of financial condition. In brief, any information concerning the assets, liabilities and net worth is information about condition.

It is clear that every business man and executive needs at frequent intervals, full and correct presentation of the facts of condition. He needs particularly forceful, clear-cut, and emphatic presentation of the several vital relationships connected with financial condition.

**30. Statements of financial condition.**—The formal, written presentation of financial facts is known as a statement. No more important statement exists than the one which lists all assets, liabilities, and capital elements. This statement has several names: Financial Statement, Statement of Assets and Liabilities, Statement of Resources and Liabilities, and Balance Sheet. While we shall use the last-named term for all statements of this type, there is very little choice in selecting the name, and the titles are used interchangeably. For purposes of discussion, we present here a balance sheet, setting forth the financial condition of a small corporation.

THE BRONSON TRADING COMPANY

BALANCE SHEET AS OF JUNE 30, 1922

| | Assets | | |
|---|---|---|---|
| *Current Assets:* | | | |
| Cash | | $1,100.00 | |
| Accounts Receivable | | 5,240.00 | |
| Merchandise | | 6,185.00 | $12,525.00 |
| *Fixed Assets:* | | | |
| Furniture and Fixtures | | 400.00 | |
| Buildings | | 5,200.00 | |
| Land | | 1,450.00 | 7,505.00 |
| | Total Assets | | $19,575.00 |

| | | |
|---|---|---|
| **Liabilities** | | |
| *Current Liabilities:* | | |
| Notes Payable | $1,000.00 | |
| Accounts Payable | 3,500.00 | |
| | $4,500.00 | |
| *Fixed Liabilities:* | | |
| Mortgage Payable | 2,000.00 | |
| Total Liabilities | | $6,500.00 |
| **Net Worth** | | |
| Capital Stock | $10,000.00 | |
| Surplus | 3,500.00 | 13,075.00 |
| Liabilities and Net Worth | | $19,575.00 |

**31. Relations brought out by the balance sheet.**—It may be seen by a study of this statement that first of all one may gain definite knowledge of the value of each asset and the amount of each liability. One may also clearly see such summary facts as:

Total Assets.
Total Liabilities.
Total Net Worth.
Current Assets.
Current Liabilities.
Fixed Assets.
Fixed Liabilities.

Significant as these amounts may be, they are not as important as certain relationships which we shall now list in what is ordinarily the order of their importance.

1. Relation of Total Assets to Total Liabilities.
2. Relation of Current Assets to Current Liabilities.
3. Relation of Fixed Assets to Fixed Liabilities.
4. Relation of Total Liability to Total Net Worth.

This does not exhaust the possibilities—and it is true that peculiar business conditions might make desirable the emphasis of some relationship not shown here.

**32. Significance of balance sheet relations to the business man.**—The first relation mentioned above is that of total assets to total liabilities. It might seem at first glance, that if one knew the amount of the excess of assets over liabilities, that is, net worth or capital, that it would suffice. Let us see why this is not so, in order that we may choose more intelligently the means of making plain this relation. A's assets are $5,000; A's liabilities are $3,000; the net worth is obviously

$2,000. B's assets are $50,000; B's liabilities are $48,000; his net worth is, therefore, also $2,000. Admitting that the amount of net worth is the most significant single fact of business condition, we may also see how inadequate it is in the cases mentioned. The value of assets, after all, in some measure is a matter of opinion, and business conditions may change their actual value overnight. If, tomorrow, assets shrink in each case 10 per cent, A will then have assets of $4,500, while B will have assets of $45,000; A will still have a net worth—B's net worth is extinguished.

Or, considering A and B from a somewhat different angle —A has five dollars in assets for each three dollars in indebtedness. B has five dollars for each four dollars and eighty cents in indebtedness. Perhaps enough has been said to show of what importance it is to make clear and definite the relation between the amount of total assets and the amount of total liabilities.

Current assets may be defined as those assets which, in the normal course of business, will be changed or converted into cash. Fixed assets, on the other hand, are those which are purchased for use in the business indefinitely. A firm expects to sell its merchandise for cash. Merchandise is, therefore, current. On the other hand, something is distinctly wrong with a concern that sells part of its chairs or pawns its office desks to raise cash. Chairs, desks, and all furniture are fixed assets.

Short-time liabilities are current. They are to be paid out of the cash on hand and the cash will be obtained from the sale of merchandise and from the collection of accounts receivable. Financial history is full of stories of enterprises with splendid equipment, buildings, and machinery (all fixed assets) which met disaster of a grievous kind, often bankruptcy, because current assets were insufficient to meet current liabilities. The excess of current assets over current liabilities is commonly spoken of as working capital. Study of finance will show certain standards of relations between current assets and current liabilities. Trained business executives know these standards; their accountants or bookkeepers have not fulfilled their whole duty until they have made the relation of current assets to current liabilities so clear and emphatic that they cannot miss any indication of an unfortunate situation then existing.

The relation of fixed assets to fixed liabilities shows the strength of the organization and indicates also the possibility of increasing the capitalization by further long-time loans. The relation of total liability to total capital is particularly interesting to creditors and those who are asked to make loans.

**33. The use of graphs in presenting major balance sheet relationships.**—A great deal of experience in dealing with figure facts is necessary if one is to draw easily correct and accurate conclusions concerning important relationships set forth in a balance sheet. While it is perhaps true that many

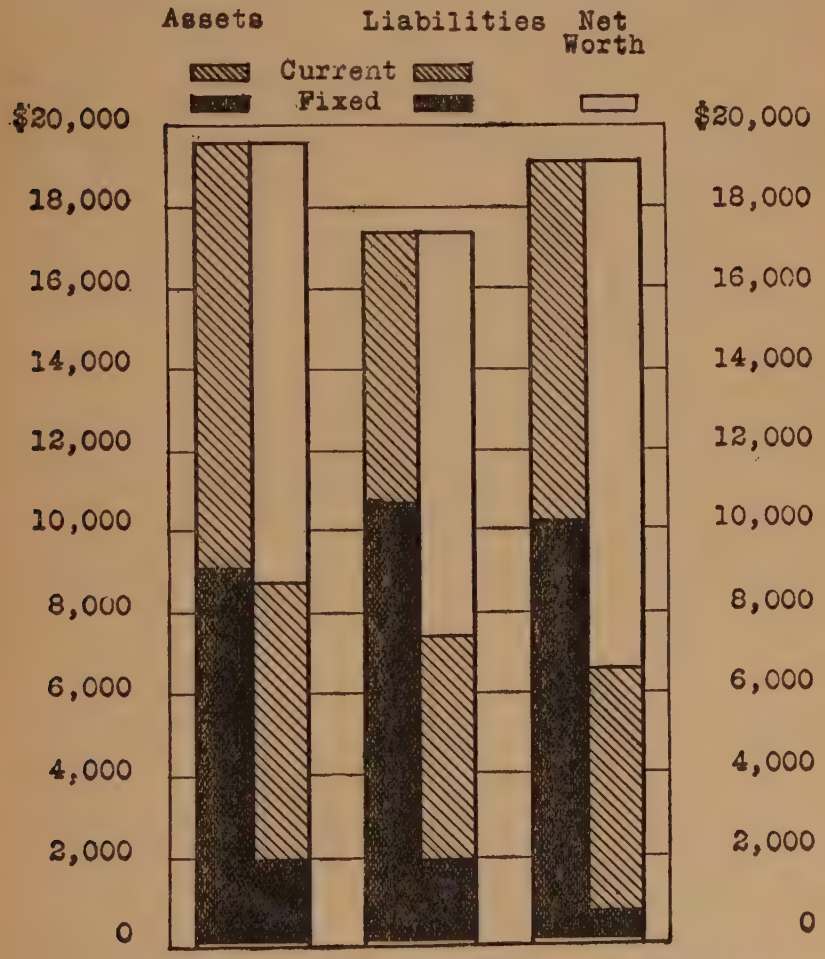



Fig. 31. Graphic Illustration of a Balance Sheet.

business executives have ability to interpret balance sheet and other statement facts, there are many others who lack not only experience but natural aptitude as well.

An example of the use of graphic charts to represent facts of condition is seen in Fig. 31. At the extreme left is a bar-chart showing the same facts as those indicated in the preceding balance sheet. The same type of blocking is used to show fixed assets and fixed liabilities. Thus they may be compared readily. In like manner, current assets and current liabilities are indicated by the same kind of marking. It is not at all difficult to see the relation of total assets to total liabilities.

A modification of the foregoing chart which would show somewhat more clearly the relation of current assets to current liabilities would be a simple bar-chart—one bar showing current assets, the other showing current liabilities. The chart in Fig. 31 will be the subject of further discussion in a later chapter.

A pie-chart might be prepared for the purpose of analyzing certain phases of condition. The writer has in mind one organization where a pie- or disc-chart was prepared, the complete disc showing total current assets and the proportionate shares of cash, receivables, and merchandise. This presentation sets forth clearly the form in which the current assets appear. From such a chart might be gained indications of over-buying or of hand-to-mouth buying, as the merchandise is disproportionately large or small. Slow collections might be suspected from an unduly large "slice" of accounts receivable and a weak cash position might also be made evident. Much the same results could of course be obtained by the use of the block-chart.

One business organization might find advisable the use of a white field as total current assets, and a black block placed within representing current liabilities. The size of the current assets field being made constant, and the block within being prepared with great accuracy to represent the proportion of current liabilities to current assets, a picturization would be given to a section of the financial condition of vital importance.

A corporation had falling due in twenty years a certain bonded indebtedness. It was not practicable for this company to issue new bonds in the place of the old. To retire the bonds at maturity, that is, to pay the holders, the corporation had

deposited money each year with a trust company. The installments were based on profits. Recently a simple chart was prepared indicating by one bar the aggregate amount to be raised before the bonds matured, showing by means of a second bar the proportionate amount which should have been raised, based on the ratio of the number of years elapsed to the total number of years over which the bonds originally ran. A third bar showed the total amount of fund. By such a comparison, it would be clear whether the provisions for bond retirement were adequate or should be modified. Many other similar uses of charts will suggest themselves.

## Chapter VIII

# GRAPHIC PRESENTATION OF FACTS OF PROGRESS

**34. Business history and the future.**—All our study of natural sciences has made emphatic the relation of cause and effect. The modern student of history sees in the activities of races, nations, and individuals, this same action and interaction between causes and their effects. A bookkeeper writes in terms of debit and credit the history of a particular business; the accountant scans the details, verifies, and seeks to draw from a mass of entries those vital facts concerning cause and effect which have operated to produce a profit or a loss. The business man reads this business history presented to him in statements of progress and tries to discover laws and principles which may teach him what to do in the future.

**35. The major facts of business progress.**—Let us consider briefly what constitute the facts of business progress. Every enterprise renders a service. The amount of this rendering of service is measured in terms of dollars and cents, and is technically known as income. Income may then be defined as the amount received or to be received as the result of the conduct of the business. In a trading or merchandising concern, it is the amount of sales; in the case of a professional firm, it is the amount of fees billed for the period; in the case of a company carrying passengers, it is the amount of the fares.

In earning this income, there are certain costs and expenses deductible therefrom. When all the costs and expenses have been so deducted, that which is left is known as net income or net profit.

Taking what is perhaps the most familiar type of business enterprise, the merchandising or trading concern, the general situation is this: the object of the owner of the business is to

buy and sell goods so effectively that the income from sales will exceed all cost of goods far enough to leave a margin from which business expenses may be deducted with a resultant net profit. The amount of this net profit is clearly the central fact of business progress.

There are other major facts of progress which we shall have occasion to discuss. Let us take a moment to define these.

**Net Sales**—the excess of total sales (at selling price) over such direct offsets as returned sales and allowances.

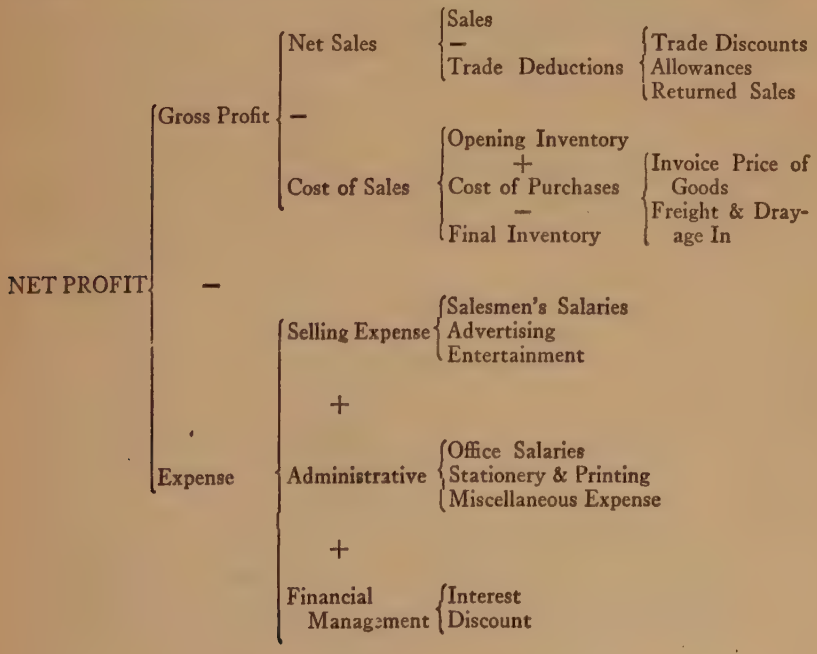
**Cost of Sales**—the total cost of all goods sold, including all costs of purchasing and receiving such goods.

**Selling Expense**—all expense connected directly with sales effort.

**Administrative Expense**—all expense connected with the general conduct of business.

**Gross Profit**—the excess of net sales over total cost of sales.

CHART SHOWING FACTS OF PROGRESS FOR A TRADING CONCERN



These definitions will, perhaps, furnish a fair basis for an understanding of the major facts of financial progress. Also, the chart which follows will assist the reader in understanding these vital elements and their relationship as well.

**36. Secondary facts of progress.**—An examination of the foregoing chart will indicate numerous items which have not been considered worthy of definition within the limitations of this book. Without mentioning many of them, it should be thoroughly understood that no little judgment and practical business insight is often required in determining their importance for some particular purpose. In many instances which have come to the author's attention, the amount of the items, "Returned Sales" and "Allowances," was worthy of special attention. The auditor or the bookkeeper discovers a volume of returned sales disproportionate to the sales. It may indicate gross carelessness, fraud, or theft. Again, if it is found in the statement of a company manufacturing goods that the volume of damaged goods in a certain division of the business is exceptionally large, defects may be expected in the operation of a certain department.

A progressive and alert-minded bookkeeper in charting delivery expense, decided to contrast it with sales volume, on the entirely reasonable theory that since a certain proportion of all goods sold was delivered, there should be a rather definite relation between sales and delivery expense. His chart showed that in one month sales increased ten per cent, delivery expense, fifty. This unusual state of affairs led to an investigation, which showed that the company's stable man was feeding, for a consideration, his friends' horses with company grain.

Many similar instances might be cited. The experienced accountant intuitively detects exceptional items and brings them to the attention of the executive.

**37. Statement of progress.**—The form of statements of progress depends in large measure on the type of business, the purpose for which the statement is prepared, and the peculiar conditions within the business. A variety of names is found—such as, Revenue Statement, Statement of Income and Expenditure, and Statement of Profit and Loss. The so-called Statement of Profit and Loss is more commonly found in trading concerns, while the closely related statement, the

Statement of Revenue and Expenditure is found very frequently in lighting companies, railroads, and public utilities generally. Professional men, such as accountants, lawyers, and the like, never use the term "Statement of Profit and Loss" in connection with the results of their business and commonly refer to their statements of progress as Statements of Income and Expenditure.

The following example of an income statement is shown to give the reader a better understanding of forms commonly used as a basis in the study of graphs.

THE BRANDON TRADING COMPANY
STATEMENT OF PROFIT AND LOSS
FOR PERIOD ENDING JUNE 30, 1922

| | | | |
|---|---|---|---|
| Sales | | | $85,376.00 |
| Deduct: | | | |
| Goods on hand, June 30, 1921 | | $18,120.00 | |
| Purchases | | 71,200.00 | |
| | | 89,320.00 | |
| Less: Goods on hand, June 30, 1922 | | 20,300.00 | 69,020.00 |
| Gross Trading Profit | | | $16,356.00 |
| *Selling Expenses:* | | | |
| Salesmen's salaries | $5,120.00 | | |
| Advertising | 2,540.00 | $7,660.00 | |
| *Administrative Expenses:* | | | |
| Office salaries | $2,050.00 | | |
| Officers' salaries | 2,200.00 | | |
| Depreciation | 610.00 | | |
| Miscellaneous expense | 487.00 | 5,347.00 | 13,007.00 |
| Net Profit | | | $3,349.00 |

The preceding statement, adopted from practice, is perhaps typical of those submitted by small trading concerns, both corporate and unincorporated. It will be seen that we have, with fair success, brought out the amount of sales, cost of sales, gross profit, selling expense, administrative expense, total expense and net profit. It has been the practice of some bookkeepers and accountants to show certain relationships more distinctly through the use of percentages. Thus, we could take $85,376 as 100 per cent, and show the relation of each group of costs and expenses to sales by expressing it as a certain per cent of $85,376. For example, the selling expense

of $7,660 is nearly 9 per cent of $85,376, and administrative expense is slightly more than 6 per cent. Such percentages will have real significance for the man or woman with an inclination for arithmetical thinking. Unfortunately, many business executives are unable to gain a clear conception of financial facts from percentage relationships. Several methods might be suggested for bringing out the relationships. For example, a "pie-chart" could be used, indicating by different types of cross hatching the portions of sales income which were used for cost of sales, selling expense and administrative expense; the remaining segment would be net profit.

Another plan would be to use a block-chart, measuring off different portions to represent the several elements. The advantage of the "pie" chart is that people have become accustomed to think of the circle as a whole—that is, one hundred per cent. The disadvantage, as has been previously stated in another connection, is that it is much more difficult to obtain accuracy in the use of the circle. With the block-graph, preferably in the form of a square, accuracy is more easily obtainable.

Obviously, bar-charts might also be used to show relation of the several types of cost and expense to sales income. This might be worked out in two ways. First, a bar could be made for each of the following: Sales, Cost of Sales, Gross Profit, Selling Expense, Administrative Expense, and Net Profit. The bars would, of course, be proportionate to the size of the several items. Or a bar could be drawn to represent Sales, with different types of cross-hatching to represent the several elements. This last method is especially valuable when progress of one period is to be compared with that of another, or where the progress of a certain department, branch, or other business unit is to be compared with the progress of other units and with that of the business as a whole. This will be discussed more fully in a later chapter.

The fundamental character of this treatment seems to make it advisable to confine our discussion to a basic form of statement designed for a trading or merchandising company. The student who wishes to study the forms of statement of manufacturing, professional, and public service enterprises, will find excellent examples in standard treatises on accounting. He should have little difficulty in adapting what has been said to the needs of these organizations.

**38. Partial statements of progress.**—Much work is involved in gathering all the facts of financial progress. For this reason, despite the desirability of presenting facts at frequent intervals, many firms hesitate to present complete information more than once each year. It is also true that frequently a partial statement presenting easily-obtained detail concerning only a section of progress may be of more significance than a complete statement of progress. For this reason, several statement forms are in rather common use, the data sometimes being presented at frequent intervals between the dates when full statements are presented—sometimes serving as schedules supporting the major statement and amplifying the facts presented therein. Two of them will be mentioned and briefly discussed.

*A.* Daily, Weekly, or Monthly Sales Statement. A report of sales volume analyzed either as to department, volume, classes of goods, or salesmen. A very useful statement for the sales manager.

*B.* Expense Analysis. A statement prepared at frequent intervals by large-scale companies in an effort to summarize expenses through a controlling knowledge of the amounts of different classes. These amounts may be compared with sales volumes, with some ideal, predetermined amount, or in any other way which will enable the executive in charge to gain a clear conception of such classes of expense items as are excessive.

Many other statements of this general nature are usable and often very valuable. In fact, any element in the profit and loss statement is susceptible of analysis in special statements. In such special presentations of facts, it may easily be seen, there is an excellent field for the use of graphs.

## Chapter IX

# THE USE OF GRAPHS IN COMPARING FINANCIAL FACTS

**39. In general.**—Frequently it becomes desirable for the owner or manager of an enterprise to examine certain facts or conditions to determine what changes have taken place or what differences exist. Some of the more important comparisons in accounting have already been discussed. We shall now discuss others in detail.

**40. Comparison of balance sheet facts.**—We have already observed that facts concerning assets, liabilities, and net worth (capital)—facts of condition—are commonly displayed in a statement known as a balance sheet. It sometimes becomes important to compare condition at a certain date with condition at an earlier date. This is often accomplished by accountants through the use of the comparative balance sheet, a simple example of which is here displayed.

FRANK BATES

Comparative Financial Statement
June 30, 1922 and June 30, 1921

| *Assets* | *1922* | | *1921* | | *Increases and Decreases* | |
|---|---|---|---|---|---|---|
| Cash | $ 950.00 | | $1,500.00 | | $ 550.00* | |
| Notes Receivable | 150.00 | | 220.00 | | 70.00* | |
| Accounts Receivable | 5,320.00 | | 4,975.00 | | 345.00 | |
| Merchandise | 11,140.00 | | 9,883.00 | | 1,257.00 | |
| Store Fixtures | 500.00 | | 570.00 | | 70.00* | |
| Delivery Equipment | 420.00 | | 130.00 | | 290.00 | |
| Total Assets | | $18,480.00 | | $17,278.00 | | $1,202.00 |
| *Liabilities* | | | | | | |
| Accounts Payable | $5,760.80 | | $5,420.00 | | $ 340.80 | |
| Notes Payable | 976.00 | | 1,340.00 | | 364.00* | |
| Accrued Salaries | 82.50 | | | | 82.50 | |
| Total Liabilities | | 6,819.30 | | 6,760.00 | | 59.30 |

| | | | |
|---|---|---|---|
| *Net Worth* | | | |
| Frank Bates, Capital. | $11,660.70 | $10,518.00 | $1,142.70 |
| Liabilities & Net Worth | $18,480.00 | $17,278.00 | $1,202.00 |

*Items should be in red.

Study of the statement will show that it serves several purposes. (1) It shows the increase or decrease in total assets, total liabilities, and capital. (2) It shows in respect to each specific asset, liability, or capital element, its increase or decrease. The last-named purpose, because of the detail required, would rarely be expressed graphically. Reference to Fig. 31 will show how effective graphs may be in presenting increases and decreases over periods of time in certain groups of assets and liabilities. The white spaces represent net worth at different times. Sometimes, as in the case of a corporation, such net worth could be broken down into its component parts—capital stock and surplus—by using various markings. Generally, however, this would not be desirable as it would greatly decrease the simplicity of the display without any marked additional utility to compensate for it. As a matter of fact, capital stock is, in most cases, unchanged from year to year and any increase in net worth would, therefore, be an increase in surplus.

It is often especially desirable to compare certain phases of condition. Working capital, for example, is a very important business factor. It is the excess of current assets over current liabilities. Decreasing working capital might suggest to the prudent executive the need for some new and drastic financial adjustment. To illustrate a condition of this sort, a single-bar chart may be drawn, one bar representing working capital at the present, another representing it at an earlier moment. In the same way, cash may be compared with cash on hand at another time. Inventories can be examined to determine whether they are excessively large.

The alert student who will acquaint himself with actual conditions in typical enterprises, will think of many other examples.

**41. Comparison of progress for different periods.**—Is the business less profitable than last year? Why? One can imagine few more important questions than these. If profits have become less, it is due to reduced income or increased costs and expenses. A comparative statement of profit and loss will

indicate, item by item, the elements in the reduction of profits.

Several graphic ways of presenting these accounting truths will suggest themselves. The chief difficulty may be reduced volume of sales, and bar-charts, each bar representing sales for a certain year, might be prepared. This might be amplified to represent sales, by means of a bar with two kinds of cross-hatchings, the whole bar representing total sales, one section representing costs and expenses, and the other net profit. A bar similarly constructed placed beside it would offer effective means for comparison. Even more effective would be block-charts, although the latter are more difficult to construct.

Specific elements like advertising costs, and cost of supplies may also be subjected to close scrutiny by the use of carefully constructed graphs.

**42. Comparison of branches, departments, and other units.**—The elimination of an unprofitable branch or department would ordinarily increase net profit. A change in management of this or that unit of a business, or the separation of certain individuals from the organization may promote its well-being and add to its profitableness. In order to gain a clear knowledge of the relative profitableness of each department, branch, salesman, or other unit, an analytical statement may be prepared showing the sales, cost of sales, gross profit, departmental expense, and net profit of each unit. That these facts may be shown graphically to excellent advantage is clearly shown in Fig. 32.

Cost of sales, sales, and departmental expense, are shown for the entire business and for each department. Certainly a display of this type would lead to several questions concerning the departments. Why, for example, is selling expense greater for "B" than for "A"? There may be, of course, some excellent reason. Often there would not be. The good margin of profit in department "C" might naturally raise the question as to whether administrative effort should not be largely spent in increasing that department. Perhaps, if demand warranted, the space now occupied by "B" might better be occupied by "C."

Nor is it inappropriate to note in passing that charts of this kind often serve as a stimulus to the individual department managers. Several years ago, a manager and part owner of a large department store, having tried several plans for increasing sales volume and reducing sales expense, quietly handed

to each department manager a chart similar to this, with a surprising result.

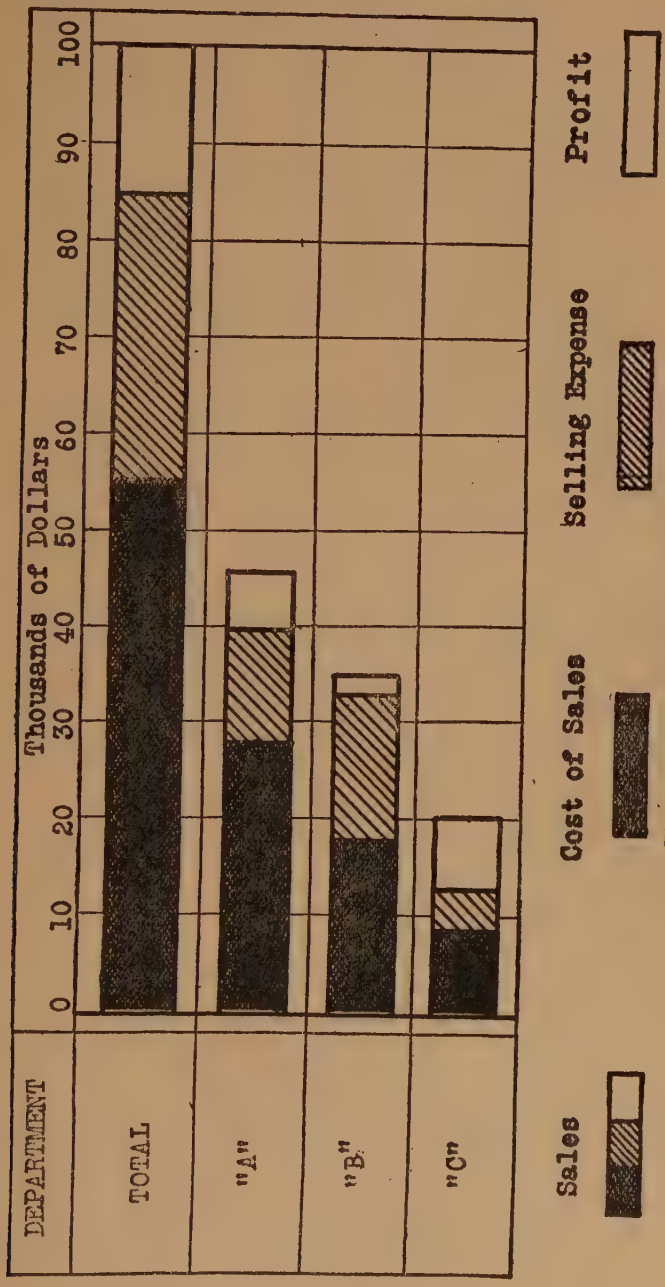



Fig. 32. Bar-chart Used in Sales Analysis.

Branches might be compared in the same way, as might also individual salesmen. A modification of this plan which has been used by some executives is to employ three distinct bars for each department, one for sales, one for cost of sale, and one for expense. Where department managers have little or no control over departmental expense, the plan can be modified by eliminating the selling expense of the department, indicating only those factors which can be controlled by the department head—sales volume, cost of sales, and gross profit.

A simple comparison may be made by using a "pie" graph. The circle represents the total sales, each segment showing the sales of a specific branch, department, individual, or other unit. Where sales volume is the only thing to be compared, this type of graph is effective.

**43. Comparison of business progress with estimates.**—Every good business man makes plans—sometimes very rough and general—at other times, complete and detailed. There is a growing tendency on the part of managers of the larger enterprises to set certain definite standards to be met by sales and department managers. With accurate knowledge of past accomplishments of the enterprise, with a rough general conception of the sales results of other enterprises of a similar nature, and with a keen sense of the trend of business in general, he works out estimates which serve as standards for future accomplishments. In like manner, estimates of expense may be worked out—and certain executives may be charged not to exceed the amounts set.

In some organizations complete estimates of all income and expenses are given permanent form in a statement known as a budget. Such a budget has many times proven its worth, not only in business but also in planning the family finances and in working out plans for the various units of government.

Statements may then be prepared at the end of each month, showing in black, actual results, and directly beside them, in red, estimated results. If estimates have been judiciously made, the several members of the organization charged with meeting the estimates will respect them and will study with interest the comparative statement which shows how far they have succeeded.

There is no question, however, but that such comparison may be made effective through the use of graphs. An example

taken from rather an unusual actual case well illustrates the principles mentioned.

COMPARISON OF ESTIMATED SALES WITH ACTUAL SALES; ALSO FIVE MONTHS' MOVING AVERAGE DURING THE CALENDAR YEAR 1921

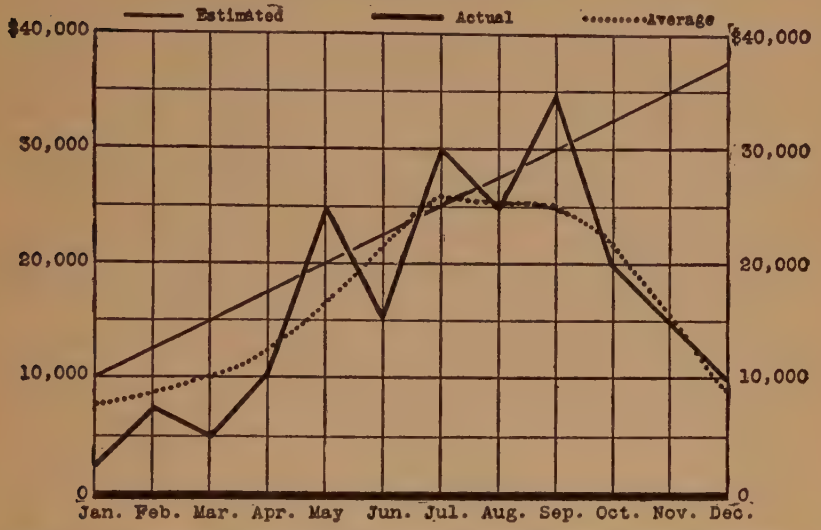



**Fig. 33. Curve-chart Illustrating Estimated, Actual, and Average Sales for a Given Period.**

Referring to Fig. 33, the light line indicates the estimate of sales for the year 1921. For example, it was anticipated that sales for January would be ten thousand dollars, that they would increase twenty-five hundred dollars in February, and would increase regularly from that time on. These sales expectations were backed up by what was believed to be a judicious and very ambitious advertising campaign. The heavy black line shows that actual sales were but $2,500 in January, that there was an excellent increase in February with a falling off in March, and then a steady improvement for several months.

The general trend of sales is best indicated by some sort of average. The average used here is what is known as a five-months moving average. This is indicated in this chart by a dotted line. The dotted line in April reaches the point $12,500. This amount is obtained in the following way. The actual sales for the two months preceding April are added to the sales for April and the two months thereafter. Sales for

February were $7,500; for March $5,000; for April itself, $10,000; for May, $25,000; and for June, $15,000. The average of these five amounts is $12,500. The next month is plotted in the same way by averaging the sales for the month with those of the two succeeding or two preceding months. This line, as may be seen, is affected but little by one month's abnormal or subnormal results. The line tends to move upward until business has a real downward tendency. A twelve-months' moving average might be used, or some other plan might be worked out.

What has been accomplished in comparing actual sales with the estimate might be done with any other business element.

**44. Comparison of an enterprise with other enterprises.** —Business secrecy, which kept information under a bushel, has been largely eliminated in modern business. Governmental agencies have made available certain summaries and synopses, of course without names of individual firms. Individual enterprises have freely opened their records to bureaus of research associated with our great universities, to trade associations, to chambers of commerce, and to expert investigators of business journals. Business men may learn from the sales experience of other organizations; they may know with assurance that certain relations of expense to sales exist. For example, it has been found that retail jewelry stores normally pay an amount for rent equal to five per cent of sales and that delivery expense in a grocery store takes about three cents of every dollar received.

It is clear that a chart might be prepared which would show a comparison between the results of a particular business organization and the experience of others. That this offers wide opportunity for the use of graphs is so evident that detailed suggestions are superfluous.

# APPENDICES

## Appendix A

# PROBLEMS ON THE USE OF GRAPHS IN ACCOUNTING AND BOOKKEEPING

(To Accompany Part Three)

1. Cash on hand and in bank is $10,000, accounts receivable are $15,000, and merchandise inventories are $12,500. The accounts payable are $18,000, of which $8,000 is due within five days, and the balance in one month. Prepare a graph to bring out the more salient facts.

2. A mail order house has increased its sales from $25,000 per month to $100,000 per month. Cost of sales (cost of goods sold) for the first period was $15,000; for the second, $85,000. Prepare a graph to bring out clearly the unfavorable tendency.

3. Selling expenses for January, February, and March, 1921, were respectively $10,000, $11,200, and $12,300. In 1922 for the same months, they were $15,000, $16,500, and $20,000. Sales were increased very little. What suggestions would you offer for the use of graphs?

4. Sales of the Eureka Sales Corporation for a certain year were $85,000, selling expense was $11,000, and administrative expense $8,300. Prepare a "pie" chart to show the analysis of sales.

5. Prepare a block-chart to display the facts in problem 4.

6. Prepare a chart which will display the most significant facts in the case of The Brandon Trading Company (See p. 89).

7. Assume that the following facts were available concerning the operation of the Brandon Trading Company for 1921: Sales, $75,000; cost of sales, $62,000; selling expense, $4,000; administrative expense, $5,100. Prepare a chart to bring out comparison of these facts with the results of 1922. (See Problem 6.)

8. Select some element that in comparison with sales is peculiarly unfavorable for 1922. Prepare a graphic chart which will cause this unfavorable element to stand out. (See Problems 6 and 7.)

9. According to a report furnished by a business research bureau, for every dollar of sales for a certain type of business, there should be expense as follows: Advertising, two cents; other selling expense, ten and one-half cents; rent, three cents; miscellaneous expense, three and one-half cents.

Actual percentages of expense for the Windsor Sales Corporation are as follows: Advertising, four per cent; other selling expense, twelve per cent; rent, two and one-half per cent; miscellaneous expense, four per cent.

Selecting those items which you consider vital, prepare such graphic forms as seem to you valuable for the manager of the business.

10. Develop a graphic chart to illustrate the comparative balance sheet of Frank Bates on page 92.

11. Sales for the years 1921 and 1922 were as follows:

| | 1922 | 1921 |
|---|---|---|
| January | $15,000.00 | $18,000.00 |
| February | 21,000.00 | 20,000.00 |
| March | 25,000.00 | 20,000.00 |
| April | 23,000.00 | 21,000.00 |
| May | 19,500.00 | 21,400.00 |
| June | 21,600.00 | 20,200.00 |
| July | 24,700.00 | 19,300.00 |
| August | 24,600.00 | 20,100.00 |
| September | 21,200.00 | 22,000.00 |
| October | 22,900.00 | 22,600.00 |
| November | 24,200.00 | 20,800.00 |
| December | 23,000.00 | 21.500.00 |

Prepare a curve-chart showing comparison.

12. Using the same facts, make a chart to bring out cumulative facts. Note that in finding cumulative facts, each unit's amount is to be added to those of all preceding amounts. For example, in the foregoing case, cumulative sales at the end of February, 1922, are $36,000; at the end of March, 1922, they are $61,000; at the end of April, 1922, $84,000.

## Appendix B

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